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U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY.

BULLETIN No. 1.

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REPORTS OF EXPERIMENTS,

CHIEFLY WITH KEROSENE,

UPON THE

NSECTS INJURIOUSLY AFFECTING

THE

ORANGE TREE

AND THE

COTTON PLANT,

MADE UNDER THE DIRECTION OF THE ENTOMOLOGIST.

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INTRODUCTION.

This Bulletin contains some communications and reports by agents of the Division on insects affecting orange trees and the cotton plant, as well as on some miscellaneous insects. We have not attempted to verify the results recorded in the reports, but have endeavored to identify as far as possible the specimens referred to.

The use of kerosene emulsions is just now attracting much attention, and as there is some conflict of experience as to their value, we repeat, in this connection, our views on the subject as recently discussed in the *Scientific American.*

On the Pacific coast the horticulturists have, during the last two years, been very active in their attempts to effectually destroy scale-insects; and Mr. S. F. Chapin, a member of the State Horticultural Commission, has recently published an extensive and interesting report (*vide* late numbers of the *Pacific Rural Press*), which bears evidence of careful work, and in which kerosene is condemned and various applications of lye and whale-oil soap are strongly recommended as sufficient for the object in view. Now, our own experience with scale-insects, and that of Mr. Hubbard, show that neither of these two substances bears comparison with a proper kerosene emulsion as an effectual destroyer of scale-insects and their eggs.

We have intimated in the annual report for 1881–'82 that the discrepancy on the Pacific coast and in Florida can scarcely be explained by difference in the species dealt with, but doubtless depends on the difference in the trees treated and the methods employed. The experiments recorded in this Bulletin refer chiefly to orange trees.

Mr. Chapin refers in his experiments mainly to pear trees, and occasionally to other northern fruit trees, the report being headed, in fact, "Scale-insects on Deciduous and Ornamental Trees." The orange is not a deciduous tree, and was evidently not experimented on. Other insecticides were used by him upon pear, peach, apple, almond, prune, and plum. Now, there is no doubt but that the action of kerosene proves more injurious to some plants than to others, and in sufficient quantity is hurtful to all. It should, therefore, be used with caution where its effects are not already known, and never employed pure. Even the orange receives a shock from its judicious application, though there is abundant proof of the fact that young, vigorous shoots of this tree will withstand a thorough drenching with the pure oil. Again, much will depend upon the condition of the tree and the time of application, as Dr. LeBaron long since showed that kerosene can safely be applied to apple trees in the spring of the year (Second Illinois Report, pp. 114, 115), or during the season of rapid growth. Again, the condition of the atmosphere will have much to do with the results, and the injury by kerosene will be greater during cool, damp weather, when evaporation is at a minimum. The fatal results in California may also be due to the large quantity used and the coarse methods of application, for Mr. Chapin's report shows that in most of the experiments it was applied undiluted, in coarse spray, while the quantity is not stated.

As two years have now elapsed since Mr. Hubbard began the use of kerosene emulsions, we recently sent him a copy of Mr. Chapin's report, with the request that he give us a *résumé* of his views, and particularly requested him to examine the trees that had been first treated with kerosene. We give herewith his report:

I have never seen any serious injury from applications of even pure kerosene. In 1880 one of my neighbors treated some very young orange trees for Lecanium scale by pouring the oil upon them from an oil can. The trees were not in very bad condition at the time, and did not appear to suffer any injury at all, and at this date they are in very thrifty condition. The applications were made at evening. On September 13, 1881, I applied to twenty-five young trees in my own grove a wash consisting of 1 pint kerosene emulsified imperfectly with 1 quart fresh milk, and diluted with 5½ quarts water. The emulsion (No. 1) was very imperfectly united, and most of the oil rose to the surface, and as the wash was applied with a brush, the first trees washed received a large amount of pure kerosene upon the trunks, branches, and in many cases upon the leaves. This application was made in the afternoon (2 p. m. to 6 p. m.) of a very hot, clear day. The trees so treated received not the slightest harm, and at this date are among the finest in the grove, and most of them have quadrupled their size within the year. About the same date (September 14) I made, as a test, an application to two young orange trees of a very unstable mixture: of kerosene, 1 pint; of milk, 2 fluid ounces; of water, 2 ounces; which, when diluted, separated and floated on top. The mixture was applied with a brush, and the oil could be seen to penetrate the leaves, so that they appeared greasy and translucent. Applied between 12 m. and 1 p. m., on a very hot, clear day. Tree A stood in the shade of an oak tree, B in the sun. September 16, 1881: B, old, devitalized leaves loosened or fallen; A, no leaves loosened or fallen. September 20, 1881: B has dropped its leaves badly; A has dropped fewer leaves. December 17, 1881: both trees apparently cleared of living scales. February 14, 1882: trees pushing out vigorously; no apparent difference in condition of A and B; no living scales can be found. To-day, November 9, 1882, these trees are in splendid condition, and have made nearly, if not quite, the maximum growth possible in the year. In these cases the effect of the kerosene has been simply to remove the scale; the rest is due, of course, to cultivation.

Another test, which I intended to be crucial as to the effect of diluted kerosene wash upon the roots of the orange, was made at the same time, September 14, 1881. In this experiment I selected a very small, two-year-old, budded orange tree, which had made no growth during the year, was starved and hide-bound, and stunted. Every orange grower knows how difficult it is to start such a tree into vigorous growth. I dished the earth around this tree and poured a gallon and a half of kerosene wash, containing 1 pint of the oil in emulsion with milk, into the cavity about the base of the tree, so that the whole of it soaked into the sand on and about the roots. The tree had but a few, yellowish leaves, and most of these dropped within a week. It, however, pushed out new leaves during the winter, and made a respectable amount of branch growth during the past summer. At this date, far from being in dying condition, it is evidently prospering as well as its gnarled and stunted trunk will allow, and I do not hesitate to say that the shock of the kerosene started it from its dormant condition. I might give other instances of applications with kerosene used unnecessarily strong or in imperfect mixtures with other liquids, in none of which have the trees been killed within the past year, but I prefer to cite only from my own notes. In the California report the concentrated solutions of lye seem to be recommended, although the effect upon the trees is evidently very severe. *E. g.*, "No. 3, concentrated lye, one and one-half pounds; water, one gallon. June 23, 1881, lye so strong as to burn bark and foliage. * * * August 2, 1881; * * * bark being restored and new foliage appearing." I should call this heroic treatment. It would never do for orange trees, because it would make them hide-bound, if it did no worse. I made four experiments with potash lye (see Preliminary Report, table 6). The strongest solution is 1 pound to 1½ gallons, applied December 31, 1881 (Exp. 43). I find I have the following notes upon the condition of the tree: January 10, 1882, "Until within two or three days, the tree has not dropped many leaves. It is now severely defoliated. January 20, has ceased to drop leaves; defoliation complete upon the most badly infested branches; no leaves dropped on the most vigorous branches; some dropped on nearly all older branches." At this date (November, 1882) the tree is alive, but seems to be suffering from a severe check, and hardening of the bark. The result on scale was not at all satisfactory in my experiments, but I have since had reason to suspect that the concentrated lye used was not a good article. Mr. Voyle, who has tried apparently the same brand, told me that he suspected there was "no *potash* in it." What was substituted he could not say, but it might be some form of caustic soda. I have had it in mind to repeat these experiments with a brand of potash known to be good. Shall I do so? In my experiments Nos. 43, 44, and 45 (see Report, table 5) the trees were in very bad condition, coated with scale. I looked at them the other day, and they seemed to me to be in dying condition. This, however, may be partly due to scale, as the lye did not clear the tree. They have, however, been repeatedly washed, with the other trees in the same grove, during the past summer, the washes used being soap and kerosene emulsions of the strength I have recommended, *i. e.*, 66 per cent. oil in emulsions, emulsion diluted nine or ten times. That the present condition of these trees is not attributable to the kerosene is shown by the surrounding trees, many of which were in equally bad condition, but *all* of which show marked improvement.

The further experience in this Bulletin, so far as it goes, bears out that above stated, and we shall continue experiments with the sole view of establishing the facts in relation to an insecticide which we have, thus far, good reason to believe is the most valuable for scale-insects, yet in our possession.

C. V. R.

MISCELLANEOUS NOTES ON ORANGE INSECTS.

By H. G. HUBBARD.

THE RUST MITE AND NOTES ON OTHER ORANGE PESTS.

CRESCENT CITY, FLA., *September* 15, 1881.

SIR: On September 1st I obtained the first specimen of a coleopterous borer in orange. I have since obtained two more from which I hope to raise imagos.* The borers were found in young trees budded three years ago. The larva had in each case begun in the dead end of the old stump above the bud. As these dead ends were only a few inches long, the borer entirely hollowed them out, and, after eating all the dead wood, descended a short distance into the living wood at the base of the budded stalk. There was always a copious exudation of gum, and in one case this had attracted an ant, which began to nest in the upper part of the gallery. Undoubtedly this borer does great harm when forced to bore into the living wood, and in many cases must cause the death of the budded part of the young tree. The obvious remedy, or rather precaution, will be to trim closely these ends of the stump, as soon as the bud has made a strong woody growth. This will be the second year after budding.

Experiments with pyrethrum extract diluted with water, and applied to leaves infested with "rust mite", have not been successful, and the mites have not been killed. Probably the extract is not strong enough. I have continued to accumulate evidence of a connection between the presence of the mites on oranges, and the subsequent appearance of rust. It is always possible to determine whether leaves have or have not been infested with the mite, although they do not remain upon a leaf longer than four or five days. The upper surface shows plainly the result of their attack in a fine wrinkling of epidermis. On the fruit there is a similar effect, and, in addition, the exuviæ of the mites adhere to the surface for several weeks after the mites have gone. I am now trying to determine how long a period elapses between the disappearance of the mites and the appearance of the rust. A number of bearing trees, on which all the fruit is bright, have been examined, and in all such cases no rust mites have been found, nor any traces of their having been upon the leaves. Trees upon which *all* the fruit is rusted invariably show the effects of the mites upon nearly every leaf. In a large number of cases where the fruit of one side, or certain branches, is rusting, the leaves of these parts show mites or their work. I have not yet found a tree in which this connection between the mite and rust upon the fruit could not be detected.

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* *Elaphidion inerme* Newm.

Experiments with Neal's mixture* give upon the whole rather disappointing results. The scales are certainly killed by it in large numbers, and if thickly and thoroughly applied, about 80 per cent. of the gravid scales with their young and unhatched eggs are killed, and very nearly all the very young scales are also destroyed. But it is also certain that it injures the tree, to some extent, by coating the bark and surface of the leaves. I do not think that permanent injury is done by it. Very much the same thing can be said of the washes in common use, most of which are compounds, in varying proportions, of soap, whale-oil soap, lye, soda-ash, and sometimes sulphate of iron and sulphate of copper. These last are very injurious to the trees, and I do not think they are very effective as a remedy against the scale. I have seen oranges entirely ruined, and with the rind eaten through, by applications of blue-stone, while the effect upon the scales appeared to have been almost nothing.

On September 3 I drove over to Welaka, on the Saint John's River, about 8 miles from here. I found the scales in about the same condition as here; no apparent difference in the number of eggs hatched. Rust appears to be doing an unusual amount of damage everywhere this year. On the way back I had occasion to examine a lemon tree which I last saw in May, 1880, and which at that time was badly infested with the "bran-scale" (*M. citricola*). It is now almost entirely free from scales, and growing vigorously, although nothing had been done to it, and the tree had not even been fertilized. I have several times seen evidence that this scale (*M. citricola*) is more subject to attacks of enemies than the "long scale" (*M. gloverii*). This may be due to the fact that it is much thinner and not so tightly cemented to the bark. At any rate it is not nearly so much feared by orange-growers, and the opinion is often expressed that it will disappear from any tree in a few years of itself if left undisturbed.

On September 4 a gentleman brought me a specimen of *Euphoria melancholica* which he had taken with others in the act of eating holes in the bark of an orange tree. He says that one of his trees has been badly attacked by them, and he has killed a number on several occasions, finding them at work on the tree. They have eaten a succession of holes through the bark, each hole about the diameter of his little finger. The bark splits between the holes where several are cut near each other. There was a small black ant feeding upon the exuding gum at the same time. It seems to me possible that the ants were the originators of the mischief and the beetles were only feeding upon the sap. He, however, thinks not. I have already reported an ant as eating holes in leaves and bark, but this supposed habit of the cetonian beetle is new to me.

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* The reader is referred to the Annual Report of the Department for 1881–'82 for a description of this mixture.

Neal's mixture appears to be effective, applied with a scrubbing-brush to the trunks of trees infested with "bran-scale" (*M. citricola*). Of two trees examined September 3, one had been scrubbed several weeks before, and hardly any young scales could be found. The other tree adjoining it had not been scrubbed; the main trunk is sprinkled over with young scales, still white in color, and with very thin shells. They appear on the bark as a whitish powder or dust. This scale is apt to be found confined to the main trunk of large trees. It spreads upward from the ground, and quite slowly, *i. e.*, taking several years to reach the branches. Many old trees have the upper portion of their trunks quite free from the scale, while near the ground the bark is thickly coated with them.

September 5.—I visited some young groves 4 miles southwest of Crescent City. The trees were badly infested with rust mite, which I found on lemon and citron, but not on limes (the limes were killed to the roots last winter). There were two bearing orange trees close to a house, but not more than the average distance (25 feet) from infested trees, which were entirely free from rust mite, on leaves and fruit, the latter not rusted in the slightest degree, and the foliage, by its glossy green, presenting a most remarkable contrast with that of the trees in the grove just over the fence.

September 6.—Examined the tree upon which I found (August 27) the little black ant eating holes in leaves. I found the ants still at work, but, as the colony is a small one, no very great damage has been done. The tender shoot most attacked has ceased to grow. It has a few Aphis upon it, and these are attended by the ant. Some of the leaves eaten are so placed that no honey-dew could have fallen upon them from these Aphis, which are, moreover, but few in number and all young. There were, August 27, a very few scales of the Lecanium on the tree; these are all dead. The ants are still gathered about the same holes they had begun when last examined, although the leaves are no longer tender and are now quite dry and partially dead (entirely dead where much eaten by the ants). The ants eat only from the under side, and devour all the parenchyma, sometimes leaving the upper epidermis and sometimes perforating the leaves.

The little coral-red maggots, feeding upon "rust-mites," and described in my last letter, prove to be Cecidomyid flies. They are exceedingly difficult to raise, and most of them dry up in confinement. Four of them, however, made little oval cocoons of white silk, after a week's confinement during which they fed but little and did not appear to grow. Three of the flies appeared in nine to ten days after making their cocoons.

A young sour seedling orange plant, entirely covered with "long scale" (*M. gloverii*), and thoroughly covered with Neal's preparation on

August 31, gives to-day, September 7, the following result: *All* the very young scales killed; nearly all scales one-third grown killed; scales half grown, 34 killed, 11 alive; full-grown and gravid ♀ scales: mother insect and all eggs dead and dried up, 22; mother insect apparently alive, but larvæ and portion of the eggs at end of scale dried up, 15; mother insect and all the eggs uninjured, 10. Of the ♂ scales, the greater part were empty at the time of the application; there were, however, some with living ♂ pupæ; of these most appear to be killed; 6 living pupæ were found. The plant, which was most thoroughly treated, has lost all the older, devitalized leaves (not a bad thing), and shows some signs of injury from the application, but may be benefited in the end. It has not started any young growth. When treated it was dying of scale attacks.

September 8.—Visited Harp's grove. Many trees (bearing, and eleven or twelve years old) infested with *M. gloverii* or *M. citricola*, or both. A tree near the house was dying from scale insect; over half of it had been cut away in former years, being entirely covered with long scale. It was washed in May last (1881) with Benham's mixture (ingredients supposed to be soft soap, whale-oil soap, potash, lye, and probably sulph. of iron, &c.), and is now entirely free from scale and bearing for the first time in several years. About 8 gallons of the wash applied with an ordinary syringe with rose sprinkler. The tree is a seedling sweet orange, and was in bloom when the application was made. The tree was very thoroughly treated, and was intended to be a test by the inventor of the wash. Several other trees, mostly infested with *M. citricola*, were shown me, washed during the early part of August; same mixture, sprinkled several gallons to each tree. On these the effect has not been so complete, and the scales are spreading again. The mixture used upon some trees has turned black and spoiled, and has had no effect whatever.

Harp's grove is and has been noted for its bright oranges; the fruit of many trees is entirely free from rust, and on these a most careful search failed to reveal any "rust-mites" on fruit or leaves. A few trees in one part of the grove show rusty fruit and mites on leaves and fruit. An occasional orange is found, the rind of which has been eaten and perforated by a lepidopterous larva. This in every case worked under a leaf which happened to be closely applied to the surface of the fruit, and had been fastened down by a web. The larva does not appear to differ from that of one of the common leaf folders, and is probably a Tortricid. The fruit perforated is invariably lost and drops from the tree, owing to the attacks of a fly maggot, which enters and feeds upon the juice, rotting the fruit. The Nitidulid beetle, *Carpophilus ferrugineus* Murray also attacks such injured oranges, and its larva also occurs in the rotting fruit.

Mr. Harp's cotton is being ragged by Aletia. The caterpillars are one-half to two-thirds grown, with younger and older worms mixed. I saw no webs, but did not hunt for them. Harp first noticed the leaves eaten about a month ago (early in August), but saw no worms at that time. He has also a field of sweet potato, the leaves of which are now about half eaten by a dark-colored, striped worm (apparently a Prodenia). A neighbor's potatoes were eaten out (the leaves) three or four weeks ago, at which time Harp had only a few worms. They "stopped for a time," and have now "begun again" in much greater numbers. The ground under the vines, at noon, was covered with worms, many of them full-grown. Harp will not poison with Paris green, because he expects the worms to leave as soon as they have eaten all the leaves, and the vines will make new leaves which he intends to feed as fodder to stock. If he poisons and saves the balance of these leaves he cannot feed them to stock.

September 9.—Discovered another Cecidomyid larva preying upon "rust mite," in company with that before mentioned. This larva is very similar to the former, but is yellow, with white tubercles. It is more slender in form, more tuberculate, the tubercles bearing longer hairs. The anal fork is longer and stouter and jointed, and the antenna-like projection from the head is longer and more slender.

September 10.—An orange-colored Reduvius invariably makes its appearance upon trees which have been infested with *Lecanium hesperidum* (this coccid is out of season and not abundant). Such trees are now blackened with a smut fungus, which appears to follow the Lecanium, and are usually foul with spiders and other predaceous insects. There are always some individuals of the Lecanium to be found, and these seem to be much relished by the larvæ of Hemerobius, Chrysopa, &c.

There are many locusts that eat orange leaves. At this season the majority of them are immature, mostly pupæ. To-day (September 10) I detected the weevil *Notolomus basalis* eating the leaves of orange. It is often found on the trees and usually in the shelter of a curled leaf occupied by a spider's egg-nest or the deserted gallery of a leaf folder. The Notolomus gnaws the upper surface of a leaf in which it has found a retreat, but does no appreciable harm as far as I have seen. When the scrub palmetto is in bloom this weevil is found in great numbers on the blossom. I do not think it has any especial connection with the orange tree beyond fretting an occasional leaf.

September 12.—Made applications of kerosene and milk to trees infested with long scale. I have no pump as yet, and am obliged to make experiments on a very small scale. The kerosene applied was stirred slowly with milk and thoroughly combined before diluting with water. The proportions were one pint kerosene to one quart fresh milk and seven quarts water.

Very respectfully,

H. G. HUBBARD.

Prof. C. V. RILEY,
Entomologist.

THE RED BUG (Dysdercus suturellus) AS AN ENEMY OF THE ORANGE.

CRESCENT CITY, FLA., *January* 17, 1881.

SIR: A few days ago I learned that the "red bug" of cotton (*Dysdercus suturellus* H.-Sch.) was puncturing oranges in Squire Harp's grove. To-day I visited Harp's grove, and found not a single orange upon the trees. The greater part of the crop has been gathered, and the remainder destroyed by the bugs. Rotten and rotting oranges lay scattered about under the trees, and upon all those which were not entirely decayed the red bugs clustered thickly. Bugs also gathered upon fragments of dry orange-peel upon the ground. Was shown a pile of fruit in packing-house, now entirely rotten, and which consisted of 3,000 oranges (counted). This fruit was destroyed in part while in the packing-house, the bugs having followed it into the house, which stands in one corner of the grove. Cotton has been planted for several successive years in the grove and fields adjoining. This year cotton is planted in one portion of the older grove, and in several fields nearly surrounding it. The cotton has not been kept picked, and stalks as well as the ground are white with the waste lint and seed. To this the bugs are now returning, although for a time they are said to have nearly deserted the cotton for the oranges. Last year I remember to have seen the red bug in moderate numbers in this and other fields in the vicinity, but never saw any on the oranges. The bug has never before been known to attract notice of cotton or orange growers in this place. Last year I found them very abundant at Hawthorne and elsewhere in Alachua County, but not extending farther north than Gainesville. Dr. McMeekin, of Hawthorne, and others about there, were seriously damaged as to cotton. I think I heard a statement by him, or some one of his neighbors, that the bug attacked oranges, but do not remember that any serious complaint was made. My notes (spring of 1879) will show what was said at that time. Here at Crescent City there has been some cotton (all "sea-island") raised for ten or twelve years, but until last year the acreage was very small. Lately a cotton-gin has been established here, and a much larger acreage of cotton has been planted in consequence by Harp and his immediate neighbors. Most of the cotton planted has been in Harp's immediate vicinity, although a number of other settlers have utilized the ground in *young* groves by planting cotton between the rows of orange trees. This practice, after one or two years' experience, is being abandoned by most of the orange-growers, but it is likely to be continued by a few natives of Georgia, who have always been accustomed to raise some cotton.

In puncturing the orange the bugs insert their fine sucking beak often its entire length, and while it seems to me that the oil of the rind is their principal food, yet in some instances they penetrate through the rind and into the pulp of the orange. Many were seen sucking dried orange peel which had been cut from the fruit and thrown upon the sand. The bugs at Harp's were in all stages of growth, and of all sizes. Many adults in copulation. As the eggs are not deposited in masses, but dropped singly in the sand, none were seen. They are evidently now breeding with great rapidity, as the weather for the past ten days has been very warm. Oranges attacked by the red bugs show no traces of punctures externally, but drop from the trees, and soon rot. The side which rests upon the ground usually softens first, but this is not invariably the case. Harp has lost a large part of his crop, and says the whole profit made on his cotton has been wiped out by the loss on his oranges. A single tree near the house, and at some distance from the cotton, still bears a few oranges upon the upper brances, 20 feet from the ground. Every orange now upon this tree has from six to twelve red bugs (adult) clustering upon it and sucking. If not picked they will drop in two or three days, and in any event they will rot.

January 18.—Heard to-day that the red bugs had attacked Newsom's grove, and immediately visited it. I found a large force of men stripping the trees of fruit and packing them for shipment. Red bugs, although not as numerous as at Harp's, were seen upon nearly every tree which bore fruit; even upon the topmost branches they were seen wandering over the fruit, and puncturing it. Many were also seen flying from tree to tree. On the ground under the trees, which was littered with freshly-fallen fruit, comparatively few bugs were seen. They seem to prefer the fruit on the tree, probably because of the shade, as the bugs do not like the direct rays of the sun. As there was an abundance of fresh fruit, the bugs did not attack scraps of orange peel upon the ground, as at Harp's. I saw in one instance a cluster of bugs sucking the pulp of a freshly-torn fragment of orange. In this case they did not insert the boring tube, nor unsheath it, but sucked the surface of the moist pulp with the tip of the proboscis, like flies. Nearly all the bugs were fully adult and winged. I saw but one or two young, with wing-pads partly developed. It is more than probable these bugs came by flight from the cotton fields at Harp's and his vicinity. Harp's is the nearest cotton. It is distant 3 miles southwest. Dr. Newsom first noticed a few red bugs in his grove about two weeks ago, but gave them no particular attention, as he was entirely unaware of their power to injure fruit. Dr. N. has raised no cotton for years. With one exception none has ever been raised by any of his neighbors other than Harp, and a few others still farther to the southwest. This exception was a single isolated field of cotton raised last year at a distance of a quarter of a mile to the south. One man in this vicinity fertilized his young grove with cotton seed two years ago, but no one has since done so. Harp and others that raise cotton in that neighborhood, of course, fertilize with the seed, where cotton is raised in the grove. Dr. N. had been absent for a week, and upon his return, day before yesterday, found the red bugs in force, and fruit dropping and rotting. I add a record of maximum and minimum temperature for this month to date, with direction of wind at noon, and character of sky, &c. The first week in January was cold, with frost the first three nights, and northerly winds in the morning. Remainder of the month warm and dry, with southerly winds and clear sky. Temperature at noon for past two weeks has been about 73°. There are no bearing groves in a direct line between Newsom and Harp. A large bearing grove, Gautier's, joins Newsom on the north, with some scrub and heavy timber between the two. The red bugs have not yet migrated to Gautier's grove.

I think this a newly-acquired habit of the Dysdercus, and one which is likely to prove dangerous to orange-growers. My reasons are:

First. The red bug is a very prolific breeder, having no special breeding season, but copulating and laying its eggs at all times when the weather is warm. It increases as rapidly as any insect I know of, and infests cotton in prodigious numbers.

Second. In this district there are no permanent plantations of cotton. The acreage varies greatly from year to year, at one time stimulating the bugs to very rapid increase, and at another leaving vast numbers of them without sufficient food. This might tend to force a change of food, and the migratory habit.

Third. The red bug is one of those showy insects which are probably protected from enemies by the possession of an acrid flavor (they do not seem to have any odor). I cannot yet observe any birds or other enemies preying upon them. Chickens, &c., do not eat them.

Orange-growers in this vicinity are somewhat alarmed, and will, I think, give up raising cotton, which, moreover, has never been profitable here. I have recommended to Dr. Newsom and others to rake together the fallen and rotting fruit into piles, as soon as the fruit on the trees has been gathered. These will attract the bugs, and they may be destroyed either with pyrethrum or, better, perhaps, with diluted kerosene, which will sink into the sand and destroy the eggs also. After the fruit has rotted, and no longer serves to attract the bugs, little piles of cotton seed may be used as traps in the same way. It ought to be very easy with some concerted action to stamp out the pest in this its beginning. I have also searched in the bushes and weedy fence corners about Newsom's place to see whether the bugs could not be detected upon some oily seeds, such as cockle-bur, urena, &c. But, apparently, the oranges have attracted them all, and I cannot find a single wanderer outside the grove.

Very respectfully,

H. G. HUBBARD.

Prof. C. V. RILEY,
Entomologist.

CRESCENT CITY, FLA., *November* 28, 1882.

SIR: Since I last wrote I have been occupied in making drawings, and have finished the rust mite and its two enemies (larvæ), Syrphus fly of orange Aphis,—larva, imago, and puparium; also, sketches and details of several other orange insects. I confine myself at present mainly to such drawings as need to be made from fresh or living specimens. Some biological work is also in progress, and I have tried very hard to breed the flies of the rust mite enemy, but so far I have failed to get specimens fit for drawing. Experiments made in September with kerosene washes on purple scale (*M. citricola*) show that the eggs are much more difficult to kill than I had supposed. They have not been killed by 66 per cent. kerosene and soap emulsions diluted 1 to 9. This scale has been somewhat neglected in my last year's work, and I now find it important to get separate results for this scale. We have been having cold weather, with several very slight frosts, and I find the action of the kerosene very severe upon the foliage when frost or cold weather occurs soon after an application. In spring or summer the amount of defoliation depends entirely upon the condition of the trees, but at this season atmospheric conditions appear to have a great influence. When the air is charged with moisture, and the nights are cold, with frost or heavy dews, the oil does not evaporate as rapidly as in warm or dry weather, and consequently the effect of an application upon the foliage is much more severe. I cannot detect any injurious effect on the bark. When defoliated, the trees push out new growth almost immediately, and it seems to be the general opinion that this is not desirable when there is danger of frost. On the whole I am inclined to think it a risk to wash trees in winter or late in the fall. If, however, the trees have been neglected, and are badly infested with scale, it is perhaps preferable to run this risk rather than to allow the scales to complete their winter brood. I expect to learn much on these points the coming winter, as I think we will have one or two frosts before or soon after Christmas.

I have carefully gone over Dr. Neal's report, and have a few comments to add to my former communication.

Dr. Neal says "the greater the percentage of rosin in the soap the better the emulsion I found it made." This may be true of the *emulsion*, but when diluted, the rosin, or a large part of it, separates from the liquid and forms a waxy scum on the surface, which clogs the pump and nozzle, and is troublesome unless removed. This scum is insoluble, and, if heated, some free oil separates from it. In murvite I think the balsam separates in the same way from the diluted wash. Whale-oil soap, notwithstanding the impurities it contains, gives no such scum.

The strongest emulsion used by Dr. Neal contains 50 per cent. of oil, and the strongest wash a dilution of 1 to 9. My experiments with milk emulsions of this strength did not in the end prove satisfactory, and I long ago decided to increase the amount of oil in the emulsion. I now use 66 per cent. emulsions diluted 1 to 9, and these, although sufficiently strong for long scale, are not sufficiently penetrating to kill the eggs of purple scale (*M. citricola*). I think that by next spring Dr. Neal will have considerably modified his conclusions, and will agree with me in recommending a higher grade and more penetrating emulsions. In regard to the *removal* of the scales from the tree by a second application one week after the first, I cannot but think that he is mistaken.

In regard to cost of the materials used in Dr. Neal's washes, his estimates are somewhat higher than mine, and I think he pays 5 cents per box more for milk (condensed), and probably a somewhat higher price per pound for whale-oil soap than we do here.

The following are my estimates for a standard wash of whale-oil soap and kerosene, emulsion 66 per cent. oil, diluted 1 to 9 (1 gallon emulsion = 10 gallons wash):

Whale-oil soap, ¼ pound, at 10 cents retail price, 2.5 cents; water, 1 gallon, nothing; kerosene, 2 gallons at 20 cents, 40 cents; total, 66 per cent. emulsion = 3 gallons, 42.5 cents; 1 gallon costs 14.166 cents.

NOTE.—There is a slight loss by water-shrinkage or otherwise, so that when small quantities are made it is sufficiently exact to put the cost of the emulsion at 15 cents per gallon.

One gallon emulsion = 10 gallons wash: cost, 1½ cents; without allowance for loss, 1.416 cents.

At wholesale rates, 18 cents for kerosene and 8 cents for whale-oil soap, the cost of the emulsion would be about 2 cents per gallon less; *i. e.*, 12⅔ cents.

With aquapult pump and cyclone nozzle, 4 gallons of wash is sufficient for 30 trees of small size, such as are usually furnished at the nurseries for transplanting; cost per tree, about two-tenths cents (exactly .18).

Trees which have been transplanted and have made two years' average growth in the grove (3 or 4 years from the bud) require one gallon of wash per tree: cost about 1½ cents (exactly 1.416 cents).

Bearing trees of full size will require from 5 to 10 gallons of wash: cost, 7 to 14 cents per tree (average about 10 cents per tree).

Very respectfully,

H. G. HUBBARD.

Prof. C. V. RILEY,
Entomologist.

EXPERIMENTS UPON SCALE-INSECTS AFFECTING THE ORANGE.

BY JOS. VOYLE.

GAINESVILLE, FLA., *October* 27, 1882.

SIR: I herewith submit to you my report of experiments on scale-insects with solutions of murvite, made as nearly as practicable in accordance with your instructions.

Respectfully,

JOSEPH VOYLE.

Prof. C. V. RILEY,
Entomologist.

In carrying on this work, difficulties of various, unexpected kinds presented themselves. The details of the various steps, successful or otherwise, taken in trying to overcome these, although consuming much time, I omit, being tedious and of little value in the presence of final success.

Every good result obtained has been carefully verified and practically tested in the field.

All items of importance noticed were recorded, even when not directly within the scope of scale insects.

The experiments have been confined to small trees for exact experiments, but for general results have been extended to trees of all sizes and conditions.

The first day's work under your directions showed the necessity of some better means of applying solutions. After a few days' delay, to make better arrangements for the purpose, tree after tree was sprayed, but the microscopic examination showed so small a percentage of eggs, that they were remanded to the general list, and attention given to general results on badly infested trees until large percentages of eggs should again be found.

Every spraying device was given a practical trial in the field, so that by actual use its advantages or disadvantages might be fully proved. This also brought a large number of infested trees under experimental observation.

The principal damage done here is by *Mytilaspis gloverii*. *M. citricola* is usually present, but in a very small proportion. In the spring a d early summer, *Lecanium hesperidum* did much damage, but after the rainy season I rarely found it. *Parlatoria pergandii* was quite unknown to me, and I find very few persons who do know it, although their trees may be badly infested by it. I rarely find it on small twigs or on leaves, but large limbs and the trunks of trees are often encrusted by it.

Ceroplastes floridensis has done no damage here, although abundant on the gallberry bushes close by orange trees.

For exact experiments it was soon found that the best means in use for the application of solutions were very imperfect and wasteful.

Where only a portion of a tree is infested, it is unnecessary to apply a strong solution to any but that part. A brush dipped in the solution was the only thorough way of doing this without great waste.

The force-pump or aquajet sent had one of the finest spray-nozzles found on any pump, but it is too wasteful for this purpose; it quickly overloads the leaves with solution; under this weight they bend down and thus prevent the spray from reaching many leaves and twigs behind them. The spray produced is not fine enough.

The eddy nozzles sent make a spray of the desired lightness, but do not throw it to a sufficient distance. They were rendered available by the following methods:

SYSTEM 1.—An eddy nozzle was attached to a long piece of small rubber tubing, and both to the end of a rod of sufficient length to hold the nozzle at any required height or position. Connecting the tube with the pump, the desired spray was entirely at my disposal.

To test its capacity and fitness for actual use, several hundred trees were sprayed, and various changes made to suit different circumstances.

The best and most economical result was obtained by dividing the labor.

SYSTEM 2.—One person takes charge of the pump and solution, another takes the rod and directs the spray. This allows the person with the rod to walk around the tree, and give his entire attention to the proper application of the spray.

For a small number of small trees a simple means was devised.

SYSTEM 3.—To a common rubber bulb syringe a long conducting tube is attached, and to this a cyclone-nozzle with a very fine aperture; then the nozzle to a short rod. To use this arrangement a small tin pail holding two or three quarts is used. The feeding tube or tail of the syringe is put into the pail and the tube tied to the bail of the pail, so that the end will be at the bottom.

The pail half filled with solution is carried on the right arm, the bulb is grasped and worked by the right hand, and the left hand carries the rod and directs the spray.

Experience with system 2 showed the necessity of some improvement. The size of the bucket is limited by the step of the aquajet. A large vessel tried proved awkward to handle. At a distance from water, the time required to bring supplies is nearly as much as to make the application. Another hand was an increase of final cost. A horse and cart require time and attention, and the horse is idle eight-tenths of the time.

SYSTEM 4.—I obtained one of the Dudley garden engines, which meets to a great extent the requirements of a majority of cases.

The reservoir contains seven and a half gallons, the pump is firmly fixed to the reservoir, which in use stands on the ground; for moving it is lifted by a lever and supported on a wheel truck, the tubing and nozzles attached as before. This implement is a very great convenience.

Although two men can do more working together than separately with this system, two are not as necessary as with the aquajet. The stability of the pump without holding, gives freedom of motion for change of position. The large quantity held in the reservoir saves time, and the truck makes moving easy, so that one man can easily and conveniently work unassisted. The wheels of the engine truck are too small for plowed grounds.

SYSTEM 5.—Placing the engine in a cart, with a further supply of solution in a barrel, driving up close to the tree, then standing in the cart, the pump can be worked and the spray directed to the exterior of the tree, driving around as required to reach all sides, is the simplest and most satisfactory method of spraying orange trees on a large scale with appliances now in market, and suggests—

SYSTEM 6.—For large groves of large trees place a kerosene barrel, with a good force pump firmly attached to one head, in a cart. A light derrick fixed to the cart, carrying a light, strong rod twenty or more feet in length, supports nozzles at certain distances, to form a continuous sheet of spray of sufficient volume that the tree will be thoroughly sprayed on its exterior by driving around near it whilst the pump is being worked.

The interior of the tree is sprayed at another time, by a cluster of cyclone nozzles, or a conical cyclone nozzle.

A cart-tank might be preferred, but the system suggested enables the cart to be used for other purposes, and the pump and reservoir to be carefully housed.

The particular make and sizes of implements used are only typical; any similar arrangement used in the same way should produce like results.

The method of proceeding has been to note the extent of apparent damage done by the insect, condition of uninfested portion of the tree, if any, the condition of surrounding trees, if cultivated, if fertilized, character of soil, position on high or low land. Examining the scales with a lens, noting the variety, if parasitized, if larvæ are running about, then turning over the scales to see if eggs are present. Taking a fair sample for home examination, then applying the solution of a known strength.

The samples taken home are examined under a microscope, the percentages of scales showing work of parasites, females with eggs, young females, males, and dead from unknown causes, ascertained by actual count. Two days after, another examination is made, the appearance of the tree and scales noted, samples taken, and percentages of living larvæ and eggs noted, as before; these visits and examinations are repeated at intervals. A standard quantity of improved murvite was used containing 50 per cent. of kerosene.

The commencement of exact experiments under your directions became a continuation of work I had been engaged in during the previous three months, which I mention for the reason that the rainy season was over when I received the commission, and very different results were obtained during the hot, dry weather following.

During the wet season, when several heavy showers fell every day, and the trees were continually damp, a strong solution was repeatedly applied to scales one day, and when examined on the next, nearly all would be gone, and within a week, on exposed parts, no scales could be found.

When the dry season came there was a great difference, the cause of which was not immediately discovered. It was found that evaporation was so rapid that a solution applied to scales dried in less than half an hour. As without moisture murvite cannot act, various means for preventing this drying were tried; success was obtained by using a large percentage of free soap. One-half pound of laundry soap to one gallon of solution was found to answer; the scales remaining moist and loose, even when exposed to the direct rays of the sun.

In dry weather, following an application of murvite with water, within a half an hour, produces a decidedly good effects. The scales of Mytilaspis turn bluish-white and leave the tree much sooner than without the water.

By using a strong solution, one part murvite to ten parts water, and as soon as the scales are loose, throwing a large, solid stream of water from a good force pump directly on the scales, if force enough be used, all the scales of Mytilaspis, Lecanium, and Ceroplastes can be washed from the branches strong enough to resist the stream.

The scales are loosened to some extent by water only. To test to what extent the loosening by solutions might be attributed to water, the scales (Mytilaspis) on a tree were sprayed with water; after a few minutes they were slightly loose. A solid stream of water from the aquajet was then played upon the scales. With the greatest force obtainable, and the stream applied to the best advantage, not one scale was washed off. The same stream used in the same way had been often used after spraying with murvite, and the scales of the same variety nearly all washed off by it.

With Parlatoria it is advisable to always wash them off. This can the more readily be done, as, from my observation, they prefer the bark of older branches and the trunk of the tree. They do not yield as readily as the other varieties, on account of their matting together; a little scratching with the end of a piece of palmetto root, a handful of moss, or any similar thing, will make it easy to wash them off, even with a spray-nozzle.

I had ten feet of conducting hose replace the usual three feet on the engine, for the purpose of taking a solid stream up to wash off limbs thickly encrusted. This should form a portion of every equipment for this work.

No positive knowledge of the value of any application to scale insects can be obtained without the use of a microscope. This instrument enables the observer to quickly ascertain the effect produced. Experience has shown that too much dependence may be placed on the microscope, and false results obtained; as, for instance, samples taken from different parts of a tree will often show a very different result in percentages. If samples be not taken for each examination from the same places, the result may be misleading. Again, the scales are not alike in adhesiveness; some loosen more readily than others after the application of an effective solution, and many of these will be blown or washed off; percentages of the remainder will not fairly show the effects; whilst if the weather be calm and no rain falls, the results may be considered fair and reliable.

By reference to numbers 2, 3, 4, and 5 it will be seen that the immediate results are well indicated by the microscope; whilst from 8 to 17, inclusive, the results appear to be very irregular, showing no proportionate result to strength of solution used. This arises in great part from scales blown off 8 to 17 by a very strong wind, the application being made immediately after a storm. The scales had been loosened by the storm in different degrees, according to exposure, and the immediate results were greater as the exposure to the storm, and afterwards to the wind, was greater. The storm spoken of lasted for thirty hours, the wind blowing a gale, the rain falling in torrents. The wind continued to blow very hard for one day after the rain ceased.

Many of the worst infested trees, most exposed to the storm, showed, after its cessation, clean bark on the storm side, the scales being blown or washed off, and on the side away from the storm they were much more loose than usual. After a few days they became much more adherent than usual.

Solutions of murvite were applied to these exposed trees the day after the storm, and in two days the scales thus treated were nearly all gone.

Repeated experiments with solutions of various strengths prove that several parasites are unhurt by solutions which destroy the scale insects; and it is generally the case that in the examination with the microscope, after the application of murvite solutions, large numbers of parasites are present and very active. In specimens 21 to 28 there may be cause to suppose that parasites had accumulated from the surrounding trees where the scale-insects had been destroyed, the parasites having lived. Parasites are not always present on infested trees. It must be borne in mind that the results given are from only one application of murvite.

In every instance it is probable that some scales escaped the spray. Where no living insects or eggs were found, it is probable that the work was finished by the parasites.

The results shown in the special experiments were verified by the general results in the field. Over two thousand trees were the subjects of experiments, and these were of all sizes, but principally from four to ten years old. Some trees, as shown by the table, would be entirely cleared of insects, whilst others, apparently alike in every way, would have a quantity of living eggs, and sometimes, but rarely, living larvæ.

The results to the tree itself are important. Those in Nos. 1 and 2 have been repeatedly verified; the quick destruction of the insects being followed by the quick recovery of the tree. In every instance where there was life below the infested portion, the dying of the branches has been arrested at the moribund wood. From the limbs that were thickly encrusted with scales, defoliated, the twigs already dead, in a few days after spraying with murvite young shoots pushed out through the loosely adhering scales and grew rapidly.

Many trees have quite regained their former size, after losing three-fourths of their branches early in the spring by scale-insect, and this recovery has been without manuring.

In some cases the slow recovery of a tree is caused by the rust mite, pointed out to me by Mr. Hubbard during his visit; the surface of leaves in such cases being rendered almost useless to the tree, it must make new foliage. In some cases what are known here as white ants are at the roots and retard recovery.

In all cases where everything else is favorable to growth except the insect, the tree makes unusually rapid growth after the application of murvite in sufficient strength to destroy the insect. Different strengths of solution give different immediate results. The record of results shown by the microscope in Nos. 8 to 17 is of the actual count made from the scales remaining on the trees; a large number had been blown off.

The examination on October 25 shows very remarkable final results, and suggests that weak solutions of murvite at short intervals may be adopted with success. In all cases further applications of a moderately strong solution should follow the first. It must be noted that these experiments were made with unusual care, every possible means being used to reach every part of the tree and thoroughly wet it. I find it very difficult to train laborers to do this without much unnecessary waste.

The ravages of the rust mite on the leaves and fruit of the orange are next in importance to the scale insect. Being almost invisible to the naked eye it escapes notice, and the leaves of the tree being damaged the tree stands still. In every case of fruit splitting that I have examined, the rust mite had damaged the leaves, and sometimes, but not always, *P. pergandii* was on the trunk and large limbs.

A solution of one part murvite to five hundred parts water is instant death to rust mites, also to migratory scale insects.

A number of large trees that were making no growth, and were not infested by scale insects, on examination were found to be covered with rust mites. These trees were sprayed with a weak solution of murvite September 14; examined October 26, they were found covered with an abundance of new shoots.

Many bronzed oranges on the trees sprayed with strong solutions of murvite whilst the oranges were growing, turned bright.*

Statements concerning the influence of soil, cultivation, manuring, and position are worthy of notice. The majority of the trees treated have been highly manured, many of them carefully cultivated. Some were on high land, some on low land, some on wet, some on dry, some exposed with no protection of buildings or trees, some close to houses and protected on every side, some on land naturally rich, others on land naturally poor, some groves well drained, some not. I find no difference in the work of the insects on trees thus variously located. In rich hammock land trees are killed down by them as badly as on high or low pine land.

A fungoid growth, of which I send a drawing, was found on Parlatoria and Mytilaspis towards the end of the rainy season, and for some time after during the dry weather of September. Whenever found with capsules developed on Mytilaspis the contents of the scales were dead. On Parlatoria its effect was not ascertained, as the insects in every stage of life, with a large number of dead, existed under the greatest growth of fungus. Disappeared about the end of September.

A red fungus was also noticed, but it disappeared before any decided results could be attributed to it. Scales of some sort were always associated with it.

Several wild orange trees, sour and bitter-sweet, quite as badly scaled as any sweet trees, were sprayed, but on examination so small a number of eggs were present that they were left for general results.

Ceroplastes is very easily destroyed. After an application of 1 part murvite to 40 parts water, in two days I could find but few on the tree, and none living.

Murvite does not dissolve readily in cold water. If dissolved in a small quantity of warm water it may afterwards be diluted with cold water to the extent desired.

The decisive results obtained by these experiments are:

The practicability of immediately arresting the progress of injury to the orange tree by certain varieties of scale insects.

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* We have serious doubts as to the accuracy of this conclusion.—C. V. R.

The retention to the tree of all infested wood that is living at the time of treatment, and restoring the tree to a healthy condition.

The destruction of the insects without injury to many of their parasites.

Preventing the bronzing of the fruit and damage to the leaves by the rust mite.

Methods of applying solutions in the most thorough manner, with the greatest possible dispatch and economy of material.

Adapting these means to the varied wants of parties engaged in orange culture.

NOTES OF EXPERIMENTS.

TREE No. 1.

August 15.—Cut down to three feet from the ground and budded; good shoots from buds. Bark covered with thick scale, variety known as hominy scale, color gray-ground speckled with white; nowhere is the bark visible. This scale has resisted everything applied to it. Applied one part of murvite to five parts water. Ten minutes after application the scale was found to be loose; it was wiped off with a wisp of dry grass, with but little force. The bark was found to be green but ridged. After cleaning, the tree had a healthy appearance; weather hot. This and surrounding trees had been highly manured; soil good pine land, a little wet, ditched.

Mr. Hubbard classified the scale as *Parlatoria pergandii*. It was covered by a fungoid growth that matted the whole together. The capsules of the fungus I found were the white spots, the general color being gray.

August 23.—Tree thriving.

September 8.—Tree has made heavy, healthy growth.

October 25.—Tree still growing.

TREES NOS. 2–5.

August 16.—Tree No. 2 is in a well cultivated, highly manured, young grove of very thrifty trees, on fine land, thoroughly drained; its trunk is 4 inches in diameter at the ground; diameter of head 6 feet; height 8 feet; has lost about one-half of its branches by *M. gloverii*. Took samples inside and sprayed with a solution of one part murvite to five parts water. Returned one hour afterward and threw a stream of water on the scales from a good force pump. The scale was readily washed off the young, smooth bark, and much was washed from the rough, older bark, but not all. A greater force would clean off all the scales. The scales washed turned bluish white in color.

Three other trees near by, similarly infested, were sprayed: No. 3 with solution 1 to 10, No. 4 with 1 to 20, No. 5 with 1 to 30. No water was used on these trees. Weather hot and dry. From each tree samples for microscopic examination were taken. (See table.)

After two days a mass of scales was taken from No. 2. In 140 only one was found with the eggs entire, all the others having collapsed.

The appearance of the scales on this tree and on the others, that had not been washed with water, was quite different. On No. 2 many scales were quite black; none where the water struck them had their natural color; all appeared as if rotting, were very loosely adhering to the bark, and could easily be washed off.

On No. 3, at first sight the scales wore their usual appearance. A closer examination showed many scales loose, but adhering sufficiently to resist ordinary winds in dry weather.

On No. 4 about the same as No. 3. On No. 5 many scales were tightly adherent.

August 23.—On No. 2, where water was applied many branches are almost free of scale. Examination with a lens showed no living insects. No sign of damage to the tree.

No. 3. Scales are loose and many shedding.

No. 4. Same.

No. 5. Scales are more adherent than on the other trees—2, 3, and 4. A living larva is occasionally seen. From sample of scales taken from No. 5, under the microscope a mass of 164 was examined, of which four had living eggs.

September 8.—No. 2 has shoots on the cleaned limbs. No. 3 shows sprouts on scaly branches; Nos. 4 and 5, no young sprouts.

September 16.—On No. 2, shoots are 8 inches long. There are some on all the others; no sign of increase of insects.

September 26.—The young on all but No. 5 are growing fast. There are some shoots on No. 5.

October 25.—No. 2. No scales on the limbs of this tree. On one twig some few larvæ and some eggs living. The young shoots are 30 inches in length. The limbs that were covered with scales have made a vigorous growth of young wood.

No. 3. Some old scales are still adhering, no larvæ or eggs among them. On some twigs are a very few larvæ and living eggs. The tree looks healthy; has made good growth; from the limbs that were infested, shoots are from one to three feet in length.

No. 4. Some old scales remain, no life among them.

No. 5. A very small number of old scales remain; a very small number of living larvæ and a few eggs were found. The tree has suffered from rust mite. It has made a little new growth.

TREES NOS. 8–20.

September 12.—From a large number of young (four to five year old) trees in a grove, all infested with insects, *M. gloverii* principally, the following were chosen for experiment. All were badly infested; all had lost wood, but showed signs of healthy roots by sending out shoots from below the parts covered by scales. These trees had been well manured; neglected for some months. The land was poor pine; part dry, well drained; part wet, badly drained; position exposed. A few trees were protected by buildings. Microscopic examination of samples is shown in table; also after two days, showing disparity already mentioned. A severe storm ended yesterday.

September 25.—Trees Nos. 8 to 17, nearly all the scales are off.

No. 18. Scales black, eggs all living, some larvæ living, tree defoliated, bark burst open, gum exuding, tree badly damaged.

No. 19. Larvæ dead, no eggs dead, tree unhurt.

No. 20. Same as No. 19.

October 24.—Trees Nos. 8 to 20 appear as follows:

No. 8. Label lost.

No. 9. Same.

No. 10. Made large growth, some scales remaining, no recently settled scales, some living larvæ, found only two with eggs.

No. 11. Healthy growth, some small masses of scale remain; no recently settled, or migratory larvæ; many living grown larvæ and many living eggs.

No. 12. This was triplicated. 12*a*. Healthy growth, some scales still remain, no living eggs or larvæ found. 12 *b*. Nearly clear of scales, found one larva living, one scale with living eggs. 12 *c*. Nearly clean, found three scales with living eggs, healthy and vigorous growth of young shoots from what was infested wood.

No. 13. Label lost.

No. 14. Has long healthy shoots, good color, many scales still adhering to old bark, no eggs found, two male larvæ living.

No. 15. Nearly all scales gone, no life in those remaining; tree making young shoots on branches that had lost their twigs, and were themselves covered with insects when sprayed.

No. 16. Scales all gone. Tree growing.

No. 17. Made healthy growth, some few scales adhering. After long search found no living larvæ; one scale with living eggs.

No. 18. Scales all gone; much bark and half the branches dead.

No. 19. Larvæ and eggs living; no benefit.

No. 20. Large number of larvæ and eggs living; no damage to tree or harm to insects.

OTHER TREES.

All of the trees in the young grove where the trees Nos. 8 to 20 were, except those retained for specimens, were sprayed with a solution of 1 murvite to 10 parts water. Examined October 24. On very few of these trees are there any scales left; all have changed their former sickly color, and the majority have made new growth.

TREES NOS. 21–28.

Eight trees were left in different places unsprayed. October 6, twenty-four days after the others were sprayed, these trees were examined. They had been fair samples of the other infested trees, and showed the extent of damage that had been prevented by the murvite used on surrounding trees. They were in very bad condition; twigs dead; a few leaves at the ends of the branches; no young growth. Microscopic examination showed the presence of an unusual number of parasites and of male insects. (See table.) These trees were then sprayed with a solution of murvite 1 to 40 parts water.

Examined October 24. Storm and rain had bleached the marks on the labels so that they were illegible. Some living eggs and larvæ were found on all; the scales were nearly all remaining on the trees.

The weather was quite cold.

OTHER TREES.

Many trees with *P. pergandii* were sprayed, but remanded to the general list for the reason that no reliable percentages could be obtained, on account of the habit this insect has of forming masses; empty scales, young broods, eggs, are all so joined and overlapped that any attempt to separate only succeeded in taking away portions of individual scales. I ascertained that the application of strong solutions effectually killed both larvæ and eggs, but I usually washed them off with water as soon as they were loosened with murvite.

August 23.—Twenty trees in very bad condition, on well-drained land, have been well cultivated and highly fertilized. These trees were infested by a round scale (*P. pergandii*). There are not very many on each tree; the trees have lost wood; in some instances nearly all is dead down to 2 feet above the ground. Some have lost all the twigs; in all the bark is black and hard. Sprayed with solution of murvite 1 part to water 20 parts.

Seven days later, find the scales loose; fourteen days later, trees showing buds on infested wood; one month after spraying, found shoots growing; two months after spraying, trees growing vigorously. Owner sprayed the entire grove, including these, using weak solution of murvite. I found no living insects on any of the trees.

Table of exact experiments.

Date.	No. of tree.	Insect.	Percentages.				Number of scales examined.	After spraying.				Number examined.	Strength of solution.	Remarks.
			Females with eggs.	Young females.	Males.	Parasitized.		Date.	Days.	Larvæ living.	Eggs living.			
Aug. 16	2	M. g.	24	43	27	0	133	Aug. 18	2	0	1	140	1- 5	One part murvite to five parts water.
16	3	M. g	23	46	26	4	140	18	2	0	4	173	1- 10	
16	4	M. g.	35	33	29	2	153	18	2	0	6	131	1- 20	
16	5	M. g	29	42	28	1	137	18	2	0	7	145	1- 30	
Sept. 12	8	M. g.	15	32	31	0	161	Sept. 14	2	0	6	123	1- 10	
12	9	M. g.	18	40	33	5	129	14	2	0	2	170	1- 20	
12	10	M. g.	12	47	36	1	143	14	2	0	3	162	1- 30	
12	11	M. g.	12	41	43	1	147	14	2	0	9	180	1- 40	
12	12	M. g.	19	40	31	6	136	14	2	0	23	132	1- 50	
12	13	M. g.	11	51	33	3	171	14	2	0	11	161	1- 60	
12	14	M. g	10	41	39	2	134	14	2	0	7	173	1- 70	
12	15	M. g.	10	41	18	27	161	14	2	0	10	134	1- 80	
12	16	M. g.	20	50	27	0	173	14	2	0	32	150	1- 90	
12	17	M. g.	21	53	27	1	152	14	2	0	27	163	1-100	
12	18	M. g.	19	60	12	5	158	14	2	*	....	....	....	Sat. solution sulphate of iron.
12	19	M. g.	24	43	28	2	149	14	2	†	....	....	....	Sat. solution nitrate of potash.
12	20	M. g.	25	40	30	2	138	14	2	‡	...	....	....	Sat. solution bicarbonate of ammonia.

* Larvæ dead; no eggs hurt.
† Some larvæ dead; no eggs hurt.
‡ Some larvæ dead: no eggs hurt.

OCTOBER 6.

Numbers.	Destroyed by parasites.	Females with eggs.	Remarks.
No. 21	Nearly all ..	2	These scales were taken in masses of about 100, and the scales containing eggs were counted. The mass consisted chiefly of broken, parasitized, empty scales; some young brood recently settled. No accurate count could be made of any but scales with eggs. Some scales of *P. pergandii* were present. A large number of males had attained their perfect form. These trees were sprayed with solution 1-40; weather cold. Examined October 24; labels were illegible; some eggs and larvæ living were found on all.
No. 22	....do	3	
No. 23	....do	0	
No. 24	....do	0	
No. 25	....do	3	
No. 26	....do	10	
No. 27	....do	12	
No. 28	....do	0	

REPORT OF OBSERVATIONS AND EXPERIMENTS.

BY J. C. NEAL, M. D.

ARCHER, FLA., *October* 10, 1882.

SIR: I respectfully submit reports of experiments upon cotton and orange insects, made under your direction during July, August, and September, 1882.

Allowing me to express my appreciative thanks for valuable aid rendered by you during the progress of the experiments, yours, &c.,

J. C. NEAL, M. D.

Prof. C. V. RILEY,
Entomologist.

REPORT OF EXPERIMENTS UPON SCALE-INSECTS AFFECTING THE ORANGE.

In my experiments, under your direction, with kerosene emulsions upon scale-insects, I have tried to find the maximum of destructive value and the minimum of cost.

The *Lecanium hesperidum* and *Mytilaspis citricola* are both abundant in this section, the latter being by far the most destructive. Last winter the cold was so slight that the growth of the scale was not affected, and trees are seriously harmed by these insects that have not been known to be infested since 1853.

I made a series of experiments to determine the value of certain common or native plants alleged to be useful for emulsions. The most of these gave negative results. The *Pteris aquilina* (root), *Sesamum indicum* (leaf), *Hibiscus esculentus* (pod), *Jatropha manihot* (root), and *Maranta arundinacea* (root) were discarded, as being not generally distributed over the State or involving extra labor or expense in preparation. But one proved of value—the root-stem of the *Zamia integrifolia.*

Another set of experiments to find the best proportions of each ingredient of the emulsion, and also the cost, was made.

A large number of experiments were made upon infected trees, with different grades of emulsions to test effects upon trees and insects. Every effort was made to eliminate errors, and I endeavored to make each experiment as complete as possible by repeating it under various conditions.

I found that kerosene combined better with dense and rather warm solutions than if the same were cold or much diluted; and that the zamia and soap solutions were easier to use if kept at a temperature of about 100° to 120° F.

EMULSIONS.

1. Four pounds whale-oil soap were dissolved in one gallon of water, with heat; to this kerosene was added gradually till it was found that one gallon kerosene made a good emulsion, capable of being diluted to 1 per cent. without at once disintegrating.

One gallon of this mixture containing 50 per cent. kerosene costs 30 cents. In several experiments with Lecanium on small trees I tried a saturated solution of tobacco, two pounds to the gallon, to dissolve the soap. This gave good results, but from the extra expense and trouble I abandoned its use.

2. Four pounds rosin soap, common bar or yellow soap, were dissolved in one gallon water. One gallon kerosene gradually added, with constant agitation, made an emulsion costing 26 cents per gallon.

The greater the percentage of rosin in the soap the better emulsion I found it made, which would indicate that such a soap for this purpose would no doubt be a valuable article in this market.

3. Six pounds fresh zamia root were grated and boiled in 3 gallons water, made alkaline by adding 3 ounces "sal-soda." After boiling an hour, the mucilage was strained, and while hot one gallon kerosene added gradually, with considerable agitation. Enough warm water was added to make the solution when finished measure four gallons. This formed a smooth, creamy emulsion, quite stable, containing 25 per cent. kerosene, and costing 5 cents per gallon.

MILK EMULSIONS.

1st. With fresh milk.

4. Emulsions containing 25 per cent., 50 per cent., 33 per cent. kerosene were each made, and gave good results. Milk, either fresh or sour, could be used with about the same action.

2d. With condensed milk.

This for many reasons was found most generally available.

Two solutions were made:

a. One pound condensed milk diluted with three pints hot water; to this one gallon kerosene was gradually added, with constant stirring. As soon as the emulsion began forming, four pints water were added, and the emulsion completed with brisk agitation. One gallon of this contained 50 per cent. kerosene. Cost, 22 cents per gallon.

b. Mr. Hubbard's formula:

Two pounds milk diluted with six pints hot water. Take six pints of the milk; add, with agitation, one gallon kerosene till emulsified, then add the remainder of the milk and continue the stirring till a smooth emulsion is formed. This also contains 50 per cent. kerosene, and costs 35 cents per gallon.

I experimented with the following dilutions:

Soaps and milk.

a. 1 gallon standard emulsion to 9 of water.
b. 1 gallon standard emulsion to 19 of water.
c. 1 gallon standard emulsion to 24 of water.
d. 1 gallon standard emulsion to 39 of water.

Zamia solution.

a. 1 gallon standard emulsion to 4 of water.
b. 1 gallon standard emulsion to 9 of water.

Values.	Cost per gallon.			
	Whale-oil soap.	Rosin soap.	*a* Milk.	*b* Milk.
	Cents.	*Cents.*	*Cents.*	*Cents.*
a. 5 per cent. kerosene	3	2.6	2.2	3.5
b. 2½ per cent. kerosene	1.5	1.3	1.1	1.75
c. 2 per cent. kerosene	1.2	1.04	0.88	1.4
d. 1¼ per cent. kerosene	0.75	0.65	0.55	0.88

Zamia. *a.* 5 per cent. kerosene; cost 1 cent per gallon. *b.* 2½ per cent. kerosene; cost 0.5 cent per gallon.

COMPARATIVE STABILITY.

After standing 10 days in quiet, the soap solutions in part disintegrated. The oil remained in and through the soap, which formed a gelatinous mass. Heat and agitation reunited the ingredients.

The milk emulsions separated into layers. The serum below easily united by shaking vigorously.

Condensed milk, *a*: in ten days a small amount of serum separated, but oil globules could not be seen; *b* acted but little differently, a trifle less serum.

Zamia.—This in ten days showed no oil globules, but appeared about as well as when first made.

EXPERIMENTS.

1. Fifty large trees badly affected with Mytilaspis. Eighty gallons of dilution *a* of *a* milk were applied with a fountain pump. The second

day the scales were loose, and a week afterward the limbs were free and clean. Many of the leaves dropped.

2. Five large twenty-year-old trees having Mytilaspis; dilution *a*, rosin soap; 30 gallons used; clean within a week; lost most of their leaves.

3. Five hundred small trees, 2 to 4 feet high, affected with the Lecanium; used 100 gallons dilution *b*, whale-oil; scale dead the third day; leaves not hurt.

4. One hundred small trees covered with the Lecanium; sprayed with dilution *a*, Zamia; scale dead the second day.

5. Dilution *d* of *b* milk sprayed on 20 large trees badly affected with Mytilaspis; 100 gallons used. In a week most of the scales loosened, and 50 gallons more used cleaned the trees of scales.

6. Dilution *b*, whale-oil soap; four large trees required but one application to destroy the scale; 12 gallons used of dilution.

7. Dilution *b*, Zamia, one large tree; one application apparently destroyed all scale; 1 gallon used.

8. Five small trees affected with Lecanium needed two applications of dilution *c*, whale-oil soap, to clear the trees.

9. Four large trees having Lecanium; sprayed with dilution *d*, rosin soap. No effect shown the third day. Applied same dilution. Scales loose the second day afterward.

10. Eight large trees; Lecanium and Mytilaspis; 40 gallons of *d*, rosin soap, in which one pound sulphide of potassium was dissolved. Of this one application seemed enough.

11. A large tree badly infested with Mytilaspis. Three gallons dilution *a* of *a* milk destroyed the scale at one application. Many leaves dropped a few days afterward.

12. Four small trees alike affected with Lecanium. Two sprayed with dilution *c*, rosin soap; scale loose the third day. Two sprayed with dilution *c* of *b* milk. A few scales alive on the third day.

13. These experiments were repeated with the general formula of one pound potassic sulphide to 40 gallons of emulsion, with the apparent effect of making a dilution ranking as *d* as valuable as that of the *a* grade.

I think it reasonable to infer from these experiments:

1. The soap solutions are more effective in all grades of dilutions than those corresponding of the zamia or milk; the potash doubtless aiding in softening the scale. In fact, in many cases, strong solutions of soap or potash have been used with good effect upon scale insects.

2. After a rain, or in the evening, all applications are more effective.

3. Two or more applications of an emulsion containing 1 or 1.25 per cent. kerosene are better than a single one of a 5 per cent. or greater percentage of kerosene, and far less liable to injure the foliage. The expense of making and applying the emulsions is often greater than the cost of the material used, and this will most likely cause strong solutions to be in greatest demand.

Experiment 1.—Labor, 90 cents; material, $1.76	$2 66
Experiment 2.—Labor, $2; material, $0.78	2 78
Experiment 5.—Labor, $1; material, $1.32	2 32
Experiment 10.—Labor, $1; material, $2.60	3 60

In one experiment requiring six gallons of the *a* solution the cost per tree, including labor, was: Whale-oil soap, 28 cents; rosin soap, 25.5 cents; "*a*" milk, 15.5 cents; "*b*" milk, 31 cents; zamia, 12 cents.

The preparation called *murvite*, evidently an emulsion of low-grade kerosene or petroleum, has been quite extensively tried. It acts when formed into a solution corresponding to the "*a*" grade, 5 per cent. kerosene, with little or no difference in looks or effects from the same grade of milk.

In many places in Florida the zamia will be found the cheapest agent to emulsify kerosene, it growing in greatest abundance everywhere in the State.

GENERAL OBSERVATIONS ON DESTRUCTIVE INSECTS.

I beg to submit a report upon insects observed as destructive to vegetation in this section, premising that, with few exceptions, the months of February, March, and April are those of greatest insect activity here, and that from lack of time I can do but little better than give a mere *résumé* of what I have observed.

Apple, pear, quince.—The leaves and tender shoots are destroyed by a leaf-folder. The larva folds two leaves together, and with silk, fragments of leaves, and its excreta forms a cylinder in which it remains during the day.[*] At full size the larva is 11$^{\text{mm}}$ long, of a purplish-gray, the head a dull red brown, with a white dot or tubercle like an eye on each side the head, a few scattering hairs over the body. It changes to a chestnut-brown cocoon within its gallery. I have not yet obtained the moth. The apple and quince are of little value here, but the pear is assuming considerable importance.

Banana.—A very small, black, stinging ant[†] damages the roots, forming a series of rooms, &c., in the older plants.

Grape.—The *Vitis vinifera* and *V. labrusca* both destroyed by a small, gray beetle; the Desmia destroys the leaves; a small yellow and black larva, striped or ringed, comes in platoons on the under side of the leaf. A large gray coleopter[‡] with long antennæ is found, and a small larva changing in a white cocoon. A leaf-cutting bee mutilates the leaves, and a small grub-worm bores the roots. I have found no Phylloxera, nor any insects upon the "Scuppernong" varieties.

Guava.—No insects reported.

Loquat (*Eriobotrya japonica*).—A leaf-folder found.

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[*] Probably *Acrobasis nebulo* Walsh.

[†] *Crematogaster lineolata* (Say.)

[‡] Unknown Cerambycid.

Orange, lemon, lime, pomolo-citron roots.—Termites* do great damage at surface, girdling the trees. A black ant† infests any bruised spot, boring into sound wood. Oiketicus girdles small limbs. Scale attacks limbs and foliage; several varieties of grasshoppers eat the tender leaves and angular wood. The *Metapodius femoratus*, *Anisoscelis albicinctus*, and *Leptoglossus phyllopus* puncture the young stems, which soon wither; the larva of the *Papilio cresphontes* defoliates whole limbs, and a small red larva, apparently a web-worm, destroys young trees by eating the leaves and buds.

Mulberry.—I have seen several leaf-rollers, miners, &c., but have no notes upon them.

Oak.—Many valuable shade-trees have been destroyed this season by a borer, that at first destroys a large area of "cambium" around its entrance; then a large hole is bored upward and toward the center of the tree. I have not obtained it. Another borer attacks the roots, or at the collar. The young limbs are infested by a very large scale and plant-lice, the leaves by various Tortricids, Geometers, &c.

Pine.—Scale on the young limbs, Lophyrus on the leaves, and a worm that bores the terminal bud and is very destructive to the regular growth of young timber.‡

The larvæ of *Sphinx coniferarum* are occasionally met with. The larvæ of Buprestris, "the Sawyer", destroy many trees. Entering a growing tree from a place bruised or hacked, they soon destroy the "cambium," and one tree thus infested apparently communicates the insect to others not previously harmed. The pine is also injured by many other insects not yet examined.

Persimmon.—Often defoliated by a Clisiocampa (?) and a leaf-roller. The Japanese varieties are infested with a white mealy bug or scale.§

Peach.—Leaves eaten by a worm; scale‖ very bad on oldish trees, often destroying an orchard; young leaves infested by Aphides, stem injured by *Ægeria exitiosa*, and a Buprestid borer. Lice on roots, and also a larva of a beetle. Fruit occasionally harmed by a worm.

Plum.—Early leaves often covered by Aphides. Leaves eaten by larva of *Papilio cresphontes*.

Artichoke.—Tops infested with Metapodius and Leptoglossus. Tubers eaten by Termites.

Beans.—Roots often thickened, spongy, and filled with lice. Stems bored out near the ground by a small, bright green larva, causing rotting of the stem. Leaves eaten by Seirarctia larva, Eudamus, and several Tortricids. Pods punctured by a gray Lytta. Seeds eaten by a beetle and weevil.¶

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* *Termes flavipes* Kollar.

† *Crematogaster lineolata* (Say).

‡ Probably a *Retinia*.

§ *Dactylopius*.

‖ *Lecanium persicæ* Bouché.

¶ *Silvanus quadricollis* Guér. and *Calandra oryzæ* (Linn.).

The prevalence of the stem borer and the Lytta renders this crop very uncertain.

Beet.—Almost a failure, owing to a worm that rolls up leaves and stems of young plants into a slimy bundle.

Beans.—Pods and flower-stems infested by a brown beetle; seeds eaten by a small white worm that makes its cocoon from a dozen seeds webbed together.

Cabbage.—Early plants destroyed by a black beetle, often destroying hundreds of plants. Last season I lost 5 acres by the *Mamestra picta*, *Plusia brassicae*, Aphides, and Pieris, and a tiny beetle, jet black, that bored into the stalk near the root. Have not seen the Strachia.

Chufa.—Roots infested by the Termites.

Corn.—Larvæ of Elater and a boring beetle destroy the corn at joints.

Sorghum.—Larvæ of Agrotis injure the young plants.

Broom-corn.—Larvæ of Heliothis attack leaves, buds, young shoots, silk, and young ears. Weevil very bad in young corn.

Cow-pea.—Same troubles as beans, *q. v.*

Cucumber, Melon, Squash.—Agrotis often takes a crop on old land. Lice destroyed the whole growth this year. The Phakellura bores young fruit; the Anasa not common.

Okra.—Leaves eaten by a larva looking like *Anomis erosa.*

Peanut.—Larva in pods. Leaves eaten by Eudamus.

Potato.—Leaves eaten by the gray Lytta.

Sweet potato.—Leaves eaten by various leaf-rollers and the *Macrosila cingulata.*

Tomato.—Leaves eaten by the Agrotis and *Macrosila quinquemaculata.* Fruit often nearly a failure from the attacks of the Heliothis.

Turnip.—Leaves eaten by a black, tiny beetle, as well as the other insects that affect the Cruciferæ. Termites and a small black ant eat the roots.

The Scale, Orange dog, and Grasshoppers on the orange; the Heliothis and weevil in corn and sorghum; the Pieris and Plusia to the cabbage and cauliflower, and the Aletia to cotton are the greatest insect enemies we have to fight in this section.

It is no exaggeration to say that the Heliothis and weevil destroy half the corn crop of Florida.

The above report seems meager, but with the experiments my time has been limited.

ADDENDA.

The "murvite" costs $1 per quart at Gainesville. This makes a 5 per cent. solution cost 40 cents per gallon; 2½ per cent. solution cost 20 cents per gallon; 1.25 solution cost 10 cents per gallon.

The small yellow ant is a terrible pest to housekeepers, invading houses and destroying all meats, sugar, lard, &c., that it can get into. It renders entomological research often futile. I have many times obtained a fine larva, and after feeding it a day or so, have found it nearly eaten by these pests; it is necessary to put the vivaria on legs, and then in kerosene, to keep out the ants.

Fleas.—These appear in February, March, and to June, then disappear until the next February—rather singular.

Mosquitoes and gnats found here only during the rainy season.

Blind mosquitoes occur in such numbers in July as often to fairly fill the air and cover the walls of houses.

Ticks very common in summer on cattle.

Chigoes, red bugs, common in hammocks around rocky points, rotten logs.

OBSERVATIONS AND EXPERIMENTS UPON THE COTTON-WORM.

The theory that the Aletia, as a perfect insect, survived the mild winters of Florida, was, I think, demonstrated as correct by finding the hibernating moth in wire-grass fields early in this year, and later by finding its eggs upon leaves of rattoon cotton in this neighborhood, and the moth in April upon sirup-painted fences.

The frost of December 7, 1881, destroyed the Aletia, larvæ, eggs, and pupæ, in pine-land fields, but in sheltered hammock locations I found larvæ as late as January 3, 1882. That morning a temperature of 30° F. destroyed all larvæ in this section.

January 15 and January 21 I saw the Aletia moth in fields that were being burned off, but not again till in April.

During November and December, 1881, and September of this year, I repeatedly buried pupæ in both dry and moist earth; but from several hundred thus treated no moths escaped.

One inch of even loose sand prevented them from gaining the surface; and of dozens brought me by planters during February, that had been plowed up, none proved to be Aletia, but were different species of Noctuids.

During the months of May, June, and the first weeks of July I made strenuous exertions to obtain larvæ or perfect Aletia, but with no avail. I visited field after field, especially points that had first shown the cotton-worm last year, and hammock fields that were usually forward in growth, and spent several days in careful search, but though finding occasional traces of larval action, no Aletia or larvæ were obtained.

During July, about the 10th, I was advised of the finding of a few cotton-worms, about 24 miles southeast of Archer, and August 1 I found a single full-grown larva in a field near Archer, but a close search showed no others discoverable in that field.

About August 10 the larvæ appeared in force 10 miles southeast, and almost simultaneously 10 miles north of Archer.

Since then their progress has been extremely erratic. In fields side by side, one would be destroyed, the other hardly disturbed. In one case a track from east to west was destroyed. This was in the center of a large field, and about 150 feet wide; the sides of the field remaining were but slightly damaged.

In this case I could see no reason for such action; there was no perceptible difference in soil or cultivation.

By August 26 the cotton-worms were in fields 9 miles from Archer, north or south; August 30 they were 4 miles each way, and, though I caused careful examination and offered rewards, no larvæ or moths could be found in intervening fields.

September 2, I found larvæ 3 miles southeast; and on the 24th, I noted a few larvæ in near-by fields.

The prevailing winds during August and September have been from the east and southeast.

South and west of Archer is a long line of barren sand hills thinly timbered and with but few planters. Though but 5 miles from Aletia-infested fields, no cotton-worms were found this year or last in these localities.

August 10, I visited a plantation 9 miles southeast and found small larvæ. August 18–20, all were pupæ, and from some dozens of pupæ obtained August 20, moths appeared August 26–28.

In this case the pupæ remained but six to eight days.

In many fields this year a gray fungoid growth appeared in small patches upon the under side of the cotton leaves, attacking generally the thriftiest plants. In these places the larvæ seemed to lack vitality, soon becoming yellow and dying before pupation. This disease has not been noticed before this year, and does not act like the "rust" usually found in worn-out land.

In many places I found an apparent antagonism existing between the Aletia and the cotton-stainer (*Dysdercus suturellus*). In fields infested with both insects, but few and often no Aletia larvæ could be found where the cotton-stainers were in any great numbers. This may, however, be only a coincidence.

In one field I found that the guinea fowl had rendered most efficient service. The cotton presented a singular appearance: the upper portion of the plants nearly leafless, the lower limbs green and vigorous.

The martins and the bull bat are of little apparent service to the cotton planter, as the martins leave this section during the full moon of August, and the bull bat some three weeks later, or about the average date of the greatest activity of the Aletia.

The loggerhead shrike has been frequently seen to devour both larvæ and pupæ of the cotton-worm, and may be well classed as especially valuable to the planter.

I had the pleasure of seeing a small, green tree frog make a good meal from the larvæ, and as this and several species of lizards are very frequently observed in the cotton fields, it is reasonable to suppose them quite destructive to the larvæ.

The following spiders I have collected upon cotton: *Epeira fera*, *Misumena vatia*, *Attus audax*, *Argiope fasciata*, *Oxyopes viridans*, *Gasteracantha*. The Attus and Oxyopes I have observed preying upon larvæ.

Three if not four varieties of ants are found upon cotton. A very small, jet-black ant; another black ant, called here among the blacks "the little men," very ferocious, and giving both bite and sting, often called the fire-ant; a light-brown ant, and a tiny, reddish ant called the sugar ant. This last is very destructive to molting larvæ or exposed pupæ, and many instances have occurred indicating that they devour the eggs of the *Aletia*.

I think most of the wasp family, with bees, ants, and other insects, are attracted to the nectar glands of the cotton, and in fact in this section most of the honey obtained in this season is from the cotton plant.

I have noted at least three species of Polistes, two of Vespa, and two of Sphex preying upon cotton-worms.

The "hornet" has annoyed me considerably by seizing worms that I was colonizing for experiments, and carrying them away, and later in the season, last year, I saw the smaller "yellow jacket" destroy many pupæ, or begin by biting a piece from an exposed surface of a pupa; the ants then would soon carry off the contents.

The large, black-bodied wasp (Polistes) destroys great numbers of molting or prepupal larvæ. One bite to each, in the side, a sip of the exuding fluid—nothing more, but the mortality from this cause fully equals all others.

The Asilid flies—three species, *Proctacanthus milberti* (?), *Laphria thoracica* Fabr., and *Diogmites discolor* L., are very common, and the Laphria does rapid and effective work now in destroying all sizes of larvæ. The Proctacanthus, early in the season, was useful in preying upon small grasshoppers that were defoliating cotton and young orange shoots. Often I have caught this fly on the ground struggling with a grasshopper at least double its size. The smaller fly (*Diogmites discolor*) is extremely active and predaceous, and I have taken it while destroying Podisus, Nezara and *Anisoscelis albicinctus*, and one while piercing a small Dragon-fly.

Parasites have been unusually plentiful this year. At least 40 per cent. of pupæ that I had saved for various purposes were destroyed by Pimpla, Tachina and Sarcophaga.

Parasitized larvæ were easily distinguished by sluggish action and a change of color to yellowish green.

As a means of prevention in Florida, and perhaps applicable to other sections, I would suggest destruction of cotton to prevent rattooning, and late planting for some years.

It will readily occur to one as reasonable that if all cotton-stalks were uprooted by January 1st of each year, and no seed planted till March, the chances of survival of the hibernating moth would be at the minimum.

A singular experiment was tried this year, with apparent success. During June, July, and August a number of stumps and log-heaps were left slowly burning near a cotton-field so that the smoke would drift over the field at night. All other fields in the neighborhood are devastated, while this field is green and, except at the western edge, shows no action of Aletia.

This instance seems suggestive. Did the creosote from the smoke in some measure poison the cotton, or was the smoke obnoxious to the moth?

In some cases where I find the *Palma Christi* growing in cotton fields there appears to be a scarcity of the cotton-worm in the vicinity, which may suggest its value as a protection.

Jute has been abundantly tried, but with no effect perceptible, and this season I could not induce any planters to accept seed and try the experiment again.

KEROSENE EMULSIONS.

As directed, I have confined my experiments to emulsions of kerosene, and noted the effects of applications of such solutions upon the cotton-plants and cotton-worms.

My efforts were made to determine: 1. Substances best adapted to emulsify kerosene; 2. Maximum dilution of kerosene destructive to the larvæ; 3. Minimum dilution of kerosene destructive to the cotton plants.

It was soon apparent that kerosene could not be used to advantage simply with water, from its tendency to collect at the top; nor if the water were made slightly alkaline or acid would much benefit be observed.

A strong solution of various soaps made a good emulsion, presenting some points of advantage.

Soda soap, potash soap, whale-oil soap, and other varieties were tried, but a cheap grade of yellow bar-soap, especially one in which rosin was largely used, proved best, and suggested the manufacture of a soap containing a still larger quantity of rosin, which could be cheaply sold for this purpose.

After many trials I found that 4 pounds of this soap to 1 gallon of hot water would emulsify 1 gallon kerosene, forming a gelatinous compound that was quite stable.

Less than this percentage of soap acted badly with kerosene, and a greater amount did not appear to emulsify a large amount of kerosene.

This mixture, containing 50 per cent. kerosene and costing 26 cents per gallon, I adopted as a standard.

I prepared the following dilutions:

A. One gallon standard solution to 24 gallons water, 2 per cent. kerosene, cost 1.04 c. per gallon.

B. One gallon standard solution to 39 gallons water, 1.25 per cent. kerosene, cost 0.65 c. per gallon.

C. One gallon standard solution to 49 gallons water, 1 per cent. kerosene, cost 0.52 c. per gallon.

D. One gallon standard solution to 79 gallons water, .625 per cent. kerosene, cost 0.325 c. per gallon.

E. One gallon standard solution to 99 gallons water, .5 per cent. kerosene, cost 0.26 c. per gallon.

Emulsions A, B, and C presented a milky color, and were quite permanent; D and E showed some tendency to disintegrate after four days' standing.

I tried solutions of many native plants, and found the zamia finely adapted for an emulsion, especially when used immediately.

Six pounds of zamia "roots" were washed and grated. The pulp boiled an hour in 3 gallons of water; then strained, and while hot stirred in 4 ounces sal-soda. This emulsified 1 gallon kerosene, forming a beautiful pinkish jelly, containing 25 per cent. kerosene, costing 6 cents per gallon. One gallon of this solution was added to 24 gallons of water. This emulsion contained 1 per cent. kerosene, and cost 0.24 cents per gallon.

Dextrine, starch, flour, mucilage of bene (sesamum) leaf, mucilage of root of *Pteris aquilina*, and other substances were tried, but proved to be of little value.

Milk emulsions.—By gradually adding, with agitation, one gallon kerosene to one gallon fresh milk, an elegant emulsion was formed that bore dilution well, but as fresh milk is often not attainable the condensed milk was used, and the following seemed most easily made:

One part condensed milk dilute with five parts water; to this add gradually eight parts kerosene, with vigorous agitation. When the kerosene disappears, add three parts water, and agitate till a homogeneous emulsion is formed.

This is more pleasant to use than soapy solutions, and costs—

	Cents per gallon.
Standard solution, 50 per cent. kerosene	22
Dilution A′, 2 per cent. kerosene	0.88
Dilution B′, 1.25 per cent. kerosene	0.55
Dilution C′, 1 per cent. kerosene	0.44
Dilution D′, 6.25 per cent. kerosene	0.225
Dilution E′, 5 per cent. kerosene	0.22

The A′ and B′ were not stable longer than two days; the remaining dilutions barely one day.

With the exception of the zamia emulsion, all others were better to use the day of manufacture.

A mixture called murvite was sent me for trial. It gave similar results to the milk emulsions, when diluted in a corresponding manner.

Effects upon the cotton plant.—These varied greatly, owing to the weather subsequent to the application.

Emulsions A and B, A′, B′, 1¼ to 2 per cent. kerosene, did not harm the cotton-plant if two cloudy or showery days followed their use. A bright sunny day scorched the tips and edges of the tender leaves badly.

Emulsions C, D, and E, C′, D′, E′, produced no bad results upon leaves or bolls, and were repeatedly tried, with uniform effects.

Effects upon larvæ.—1. I colonized five hundred full-grown larvæ upon five cotton plants, and sprayed them with emulsion A, soap series. In five minutes forty larvæ dropped off the plants. trembled, and soon died; in an hour but one hundred remained, none feeding, all hanging from the stems and leaves; in three hours but eight survived; the next day all were dead, and the cotton leaves badly withered.

2. I prepared forty gallons of solution B′, milk, and sprinkled thoroughly one-fourth acre of cotton. The stalks average seven feet in height. and the worms were very plentiful.

The next day apparently but one in each hundred were living; the day following that the difference was quite marked, and at this time, three weeks afterward, the surrounding cotton is defoliated. the sprinkled section remaining vigorous and green.

3. I colonized one hundred larvæ, all ages, on a cotton plant; sprayed these with solution C′, milk; fifteen worms fell off in twenty minutes; the remainder quit feeding. The next morning but two remained, feebly alive.

4. One hundred large larvæ were colonized and sprayed with solution D′, milk. In ten minutes ten dropped off; in half an hour but thirty-five showed vitality; in four hours all were dead.

5. One hundred larvæ. small size, were sprayed with the one per cent kerosene-zamia emulsion; all died within an hour.

6. One hundred small larvæ sprayed with emulsion B, soap, died in one hour.

7. Three hundred large larvæ were sprayed with solution C′, milk. The next day but twelve showed signs of life, and they were evidently moribund.

8. Three hundred large larvæ were sprayed with the zamia emulsion; all died within four hours, and the repetition of experiment 3 with this solution gave better results than with milk or soap emulsions, the zamia perhaps contributing some toxic action.

I repeated these experiments with all the emulsions till satisfied that an emulsion of one per cent. kerosene, thoroughly applied, was fatal to all larvæ it reached, and harmless to the cotton plant.

I noted that as soon as sprinkled the small larvæ stopped eating, straightened, and quickly fell to the ground. Older larvæ would tremble, evacuate fæces, and hang suspended some time. The anal extremity lived longest.

The addition of one pound sulphide of potassium to forty gallons of any emulsion seemed to increase the rapidity of its toxic action, but it is objectionable as to smell and its destructive action upon rubber hose.

The sulphides will bear further study.

Still, with all these emulsions, their cheapness and safety, I have a grave doubt as to the applicability of any to long-staple cotton.

I tried a number of experiments to determine the minimum quantity needed to thoroughly spray an acre of cotton during August or September. In one very carefully conducted experiment I found most of the plants averaged 6 feet high, in rows of 4 feet apart, and 2 feet between the plants in the drill.

In this case 160 gallons barely sufficed for one-half an acre, and as it could not be applied from a cart it was hand-carried. Two field hands required four hours to complete the experiment.

The labor of preparing solutions, and of carrying and using a fountain pump, will prevent small farmers, especially colored people, from trying these remedies.

The cost of this experiment was, 160 gallons solution C′, 70 cents; labor, 60 cents, or $2.60 per acre, and with the close margin between profit and expense in cotton-growing, this slight cost will deter many.

Invasions of cotton-worms in October do but little harm. The larvæ feed only between the temperatures of 72° and 92° F. The night temperature of October averages 65° to 68°, and the larvæ remain quiet till the mercury stands at 72°. At 50° the larvæ rapidly turn yellow; at 45° they swing helpless from the leaves and soon die.

The pupæ survive 35° if shaded from the sun and the cold does not last more than a few hours.

Early in the season the Heliothis destroyed at least one-third the cotton bolls, and now cotton-planters complain of the cotton-stainer. These insects have done more damage here than all the Aletia. In many cases the young bolls are found filled with the weevil (*Sylvanus quadricollis* Guér.) and small red worms (*Batrachedra rileyi* Walsingham), and planters believe that tiny worms act independently of the Heliothis. These larvæ are described on page 98, Patent Office Report, Agriculture, 1855.

The larvæ of the *Agrotis* (generally *annexa*) do some damage to early cotton—February-planted—and two or three species of grasshoppers and crickets at one time threatened the destruction of the entire crop. Plant-lice were not so numerous, for some reason, on cotton, though whole crops of melons were destroyed by one species of Aphis.

In several instances I noted a small gray coleopter (*Epicauta strigosa* Schön.) devouring pollen and the base of the stigma of the cotton flower. Some such action, no doubt, as well as that, well known, of the Heliothis, destroys the smallest bolls.

The *Anisoscelis albicinctus* (Report of Agricultural Department, 1875, page 119) has been seen puncturing the cotton bolls and young shoots, and is very destructive to the tender orange twigs. The cotton-stainer (*Dysdercus suturellus*) also aids in the destruction of small cotton bolls.

In several instances I observed larvæ infested with an exceedingly small "mite," which soon produced death. I have not been able to fully make it out, but it appears to be an active, yellowish louse infesting the larvæ when full grown.

As to the question of an alternate food plant, I have as yet found none in Florida, but will investigate further.

REPORT OF OBSERVATIONS AND EXPERIMENTS ON THE COTTON WORM (ALETIA XYLINA).*

BY PROFESSOR R. W. JONES.

OXFORD, MISS., *January* 11, 1883.

SIR: The spring of 1882 was not favorable for the early planting of cotton. Cold, wet weather delayed the work of farmers very generally. When the plant came up, it seemed to display less vigor than usual, grew slowly, and early in the season it suffered much from the Cotton Louse (*Aphis*). It was, therefore, later than usual when it attained its full growth and commenced fruiting. The autumn, however, was favorable. There was nothing to interfere with the growth or to arrest the fruiting until November 13, when the thermometer fell to 37°, and the night of the 14th it went down to 28° F. This qualification of the above statement should be made, viz: that from the 19th to the 21st of October, inclusive, the nights were cool, the thermometer falling on the 21st October to 46° F.; but vegetation was unhurt, and whilst the worms seemed somewhat chilled early in the morning they did not fall from the plant, and as the sun warmed the earth and air they resumed their activity.

In October we had the unusual phenomenon of the leaves finishing their growth, thickening, withering and falling, without having been touched by frost. They seemed to fade, to become sear, and to die simply because they were no more able to perform their function. Their work was done. Quickly new buds, leaves and stems were put forth, and on this second growth of tender leaves there was a large brood of Aphides, differing in appearance much from those in spring. The color was dark, the legs long and black. These Aphides, as well as those in spring, were attended by immense numbers of ants.

In the spring and throughout the summer the ants were mostly the small red ant, known as the house ant, *Myrmica molesta;* there were a few black ants a little larger than the red.

In the fall, on these new leaves, and attending the dark-colored Aphides, were three varieties: (1) The small red. (2) A black ant twice the length of the red. (3) A brown ant nearly thrice the length of the red, with an abdomen more enlarged and rounded than usual, and exhibiting clear spots.

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* Professor Jones was instructed to continue experiments with insecticides upon the Cotton Worm, and to report in addition upon:

1. The real influence of ants upon the Cotton Worm.
2. Work of other enemies of the Cotton Worm.

The Cotton Worm (*Aletia xylina*) appeared in this vicinity the latter part of August. In many other parts of the State it appeared earlier, and had a much longer time to depredate. I traveled along the line of the Mobile and Ohio Railroad, stopping at half a dozen places, and found the worms in some places in the prairie in large numbers and doing considerable damage in August. I did not revisit that section, and therefore do not know to what extent the ravages were pushed. At that time the conditions there, as well as here, were most favorable to the multiplication of the insects; it was very warm, and rain was falling at very short intervals. Whilst the cotton there was late in starting and the fall was favorable for its maturity, the Cotton Worm had an unusually good beginning and prospect. The indications at that time were that much damage would be inflicted by them.

The field near here, in which I first found the worms, and in which I observed them through the season after their appearance, was one that had been *cultivated negligently*. There was in it a large quantity of "crab grass," which furnished lurking places for moths. Other fields separated from this by only a short distance, in one or two places only by a fence and road, were scarcely attacked at all. I inferred from what I saw that careful, clean cultivation contributes largely to the immunity of the crop from the depredations of these pests, and therefore pays. Most of the land in this field is undulating; a small part lies along the bed of a stream which flows freely in winter and spring, but becomes dry in summer; this is flat, level land. The undulating land was a sandy loam, quite open, porous and friable, allowing water to sink through it with great ease. The bottom had somewhat more of stiffness and compactness. I am thus careful to mention the characteristics of these soils because it would appear that the undulating lands would furnish more favorable habitations for ants and some other insects supposed to devour Cotton Worms. It is a fact that the undulating lands had far more ants than the "bottom"; but it is also true that there were more Cotton Worms on the undulating lands. Where the ants abounded, there the Cotton Worms abounded also. This fact contradicted my expectation, but the fact stands true nevertheless. I have no explanation of the relatively diminished numbers of worms on the flat lands, unless the following observations account for it: (1) The cotton was larger on the level land, the leaves larger, coarser, and apparently tougher. (2) There were many more spiders on the lowlands. Several times I saw spiders eating worms as they became quiescent, having spun a few threads about themselves and rolled the leaf just before becoming pupæ.

During the warm wet weather in August and the earlier part of September the worms increased rapidly, especially on the undulating lands. Before the middle of September the weather became settled, clear and warm. When the second brood of worms formed moths, thousands of them could be found in the daytime concealing themselves in the dense and tall grass that had grown on the cotton rows, and yet the next brood of worms was small. I watched closely, trying to discover the cause of the diminution. I conjectured that ants were devouring the young worms, and gave them close attention. One day I saw two small red ants (*Myrmica molesta*) bring a half-grown Cotton Worm down the stalk of cotton. Upon examination I found the worm had been wounded apparently it had been pierced, and it was almost dead. I could not tell whether the injury to the worm had been done by the ants, or whether they had seized it after it had become helpless. After this, although I watched closely, with the impression on my mind that ants did in all probability destroy worms, I found at no time ants attacking or devouring them, nor did I see any indications to this effect. When I saw lines of ants traveling through the cotton field I frequently disturbed their movements by breaking up their path in some way, and then I frequently put pupæ and larvæ within easy access. Again, I oftentimes put worms and pupæ near them on the ground without disturbing them in any way. I also brought worms, pupæ and ants to the laboratory and imprisoned them together, meanwhile feeding the worms. The cotton insects suffered nothing from the ants. I saw repeatedly ants eating the cast-off skins of worms and the chitinous integuments of pupæ from which the moths had bursted. I saw ants around the eggs of Aletia, eating them; I think they eat the fresh eggs; I know they eat the membrane that covers the albuminous material of the egg, and I am pretty sure, from all I saw, that they devour the whole egg. This would explain the small brood of worms coming from such a swarm of moths, and I think this is the way they check the multiplication of this enemy to the cotton crop.

EXPERIMENTS ON THE EGGS.

I frequently brought into the laboratory leaves of cotton bearing eggs of Aletia. The walls of the laboratory are thick, and the temperature there is never very high, even in midsummer. These leaves I disposed of in two ways: First, I put some in glass jars, on which ground-glass plate covers were lightly laid; second, others I shut up in cylindrical tin boxes, holding about a pint each, with tightly-fitting tops; these boxes were such as those in which buhach is sold. Of those put in glass cages none of the eggs ever hatched. If they did I could not find the worm. The leaves quickly wilted, turned dark, and after a while became black, giving off the odors of decomposition.

On the leaves put into tin boxes eggs hatched, and the worms were fed until they reached full growth, webbed up, and formed moths. When the tops were put on tightly the atmospheric communication between the inside and outside was very slow. The moisture and color of the leaf were retained for many days. These caged larvæ got no light, except when the tops were removed for taking out the refuse matter and the introduction of fresh food. It seems fairly inferable that, first, no very high temperature is essential to the hatching of the eggs; and, second, that light is not necessary to this, nor to the growth of the larvæ. I put some larvæ in a glass bottle and stopped it air-tight. They died in twenty-four hours.

TACHINÆ AND ICHNEUMONS.

During the month of October I think at least *half* the Cotton Worms I saw bore the eggs of parasites. Of these I sent specimens to you several times, and they were pronounced *Tachina aletiæ* Riley, and *Pimpla conquisitor* Say. Since they were determined by yourself, and have already been described by you in Bulletin No. 3, I need add nothing except my testimony that they are most effective checks to the multiplication of Aletia. I did not see them until the latter part of September; they were on two broods of worms. Generally there was only one egg to a worm, occasionally two, quite rarely three or four. I put many of these parasited larvæ in cages and fed them; never yet have I seen one bring forth the Aletia moth, but always there comes instead the imago of the parasite. When occupied by the parasite, the pupa case becomes darker than when the Aletia pupa is alive, and the case loses those bright-yellow circular bands which it shows when the pupa is alive.

The first week in November I found crawling on the ground a half-grown worm which bore a cluster of eight eggs. These eggs had not the appearance of those of the parasite above mentioned; they had a clear greenish hue. I sent it in a wooden box by mail, and regret that when the box reached you the worm was not found. I saw no other parasite eggs like these.

The brood of worms which followed the appearance of *Tachina aletiæ* and *Pimpla conquisitor* was very small. The cool nights from the 19th to 21st October did them no apparent injury, and their destruction must have been due to these parasites.

My observations did not discover any insects that depredate on Aletia other than ants, spiders, Tachinæ and Ichneumons.

BOLL WORMS.

During August and September, boll worms (*Heliothis armigera*) did much damage here. In August, next day after a rain, I saw a green soldier-bug (*Raphigaster hilaris*) almost concealed in a hole made by a boll worm. I let it remain in the field for a time, watching whether it would destroy the worm. I then brought it to the laboratory and fed the worm on bolls for five or six days in a cage with the bug. No injury was done the worm; it reached its full size and went down into the ground. I left the bug in the cage, and it died. It evidently fed on excrement and the contents of the boll, which decayed because of the perforation by the worm.

PREPARATIONS FOR DESTROYING THE WORMS—PARIS GREEN.

I employed this mechanically suspended in water, 1 pound to 80 gallons, to which a little flour paste had been added; it killed the worms pretty generally after they had eaten it. The same is true of arsenite of potash dissolved in water.

Some persons here employed London purple, and reported adversely on it. They applied it while the rain was falling daily, and without any paste to give it adhesiveness to the leaves.

I also used sulphate of zinc, 1 pound to 40 gallons of water; this killed 10 per cent. of the worms, but it is easily washed from the leaves, because of its ready solubility in water.

PYRETHRUM.

I made experiments this season with this vegetable substance, which confirmed what had been said and written in regard to its remarkable insecticide properties; indeed, nothing that I have seen or handled is comparable to pyrethrum for quickly and safely destroying the worms. I found that the powder suspended in water and sprayed on the plants is almost as effective as the carefully prepared and subsequently diluted alcoholic extract.

I planted the seed you kindly sent me last spring, and have now some healthy plants growing; these have not yet bloomed. I will report further in regard to them hereafter.

I made infusions and decoctions of the following:

1. Boneset (*Eupatorium perfoliatum*), one ounce of dried leaves to a pint of water.
2. *Euonymus*, one ounce of dried bark to a pint of water.
3. *Solanum nigrum*, dried leaves, stems and berries, 2 ounces to a pint of water.
4. *Solanum aculeatissimum*, as No. 3.
5. *Solanum pseudocapsicum*, as 3 and 4.
6. China berries (*Melia azederach*), as 3, 4, and 5.
7. Mock-orange fruit (*Prunus caroliniana*).
8. White clover (*Trifolium repens*), 2 ounces to a pint of water.

These preparations were carefully made, and as carefully applied. They exhibited no insecticide properties either by contact, like Pyrethrum, or by consumption, like arsenic.

I think it is not necessary for me to go into particulars in regard to the preparation and mode of application, except to say that I followed the usual methods, as prescribed in Parish's Pharmacy and other similar works, and employed a fountain-pump with fine rose.

Of the Solanum berries I made alcoholic extracts, and used these also, after diluting them first with ten volumes of water, and afterwards with only five. These proved as valueless as the infusions and decoctions.

I have the honor to be, very respectfully, &c.,

R. W. JONES.

Prof. C. V. RILEY,
Entomologist, United States Department of Agriculture.

REPORT UPON THE COTTON WORM, BOLL WORM, AND OTHER INSECTS.

By Judge LAWRENCE JOHNSON.

HOLLY SPRINGS, MISS.,
October 10, 1882.

SIR: Commencing July 1 to make diligent inquiry, by voluntary newspaper articles and otherwise, concerning insects injurious to cotton and other crops, I found, this season, the northern belt unusually free from our insect enemies. The first complaints, and the only ones heard this month, were from the gardens. In these the European Pieris had made an early appearance, the striped Diabrotica had made cucumbers and melons impossible. and *Strachia histrionica* had never left them from the fall preceding. These pests are mentioned because only on them could I try poisons at that time.

My first experiments, to prepare an emulsion of kerosene, were only partially successful—I should say failures. Application of my imperfect emulsion to cabbages was the nearest to success. It effectually killed the worms whenever sufficiently applied from a small sprinkler, and did *not kill* the cabbages, nor always injure them. But every effort to help the squashes, cucumbers, and melons killed the plants or failed to scare the Diabrotica. The emulsion was mainly applied to the earth around the plants. The beetles would come out of the loose ground and fly away, but would be found again on the plants. They were specially destructive to candytufts on a border. The earth of the whole bed being very loose, they could easily shift their hiding places. Pyrethrum powder was most successful against these, but it had to be renewed frequently and of a greater strength than for caterpillars, one to ten of flour being found about right, blown on by a small bellows offered in market for the purpose—that is, the drug stores which sell the powder generally have the bellows also.

The most obstinate pests were the Harlequin bugs (Strachia). If pyrethrum ever killed them, I never found it out. Though the tincture applied to cabbage-heads seemed to sicken them and drive them out awhile, I never got it strong enough, or it was too volatile to be effectual.

Kerosene emulsion will kill these bugs if it can be applied to the abdominal portion of their bodies. But there is the trouble. A mere wetting of the leaves, which can generally only reach the upper surface and the axillary portions next the stalk, scarcely ever catches one of them. They are shy, and dodge around like squirrels on a tree. War must be made upon them by co-operation of all the gardeners of a vicinity, and winter, in this latitude, is the time for the campaign. The burning of the trash and litter on the surface before breaking up will destroy many. But their great asylums are the green plants so common here. Lettuce and many kinds of mustard grow in Mississippi during winter in the open air, and the great southern crop of greens (collards), whether standing out or sheltered, fosters the bugs. But the great nursery for them, sorry to say, is the horseradish. Many gardens here have luxuriant bunches of horseradish, giving them an air of life in the dead of winter. If I can only be at home this winter, I shall not forget to give this evergreen a plentiful taste of kerosene.

No cotton worms (Aletia) were heard of in this northern portion of the cotton region until about the 15th of August. When summoned to the spot, twelve or fifteen miles south, I found a second brood in full force: more probably this was a third. A very simple calculation showed that they must have been colonized there as early as the middle or last of July. The planter on whose lands they had first begun was a gentleman of uncommon intelligence, and a good, successful farmer, but neither he nor his tenants had noticed the worms until, as if by magic, they were scattered all over his fields and his neighbors'. No instance better illustrates the value of the advice you have so often given to planters of the middle and northern cotton belts—to look out for the first patch of ragged leaves, or, better still, even before that, to notice for the first spotted foliage. It was not difficult to convince this gentleman, and even to find the *spot* in his field where he might at one time have covered the whole army with two or three tablecloths; and this, I think, was as early as the 1st of July. What a pity in this case, when I was on the inquiry and lookout for a chance to experiment. An ounce of Paris green or London purple or a half-pint of kerosene would have saved these two or three counties north of Tallahatchie River some thousands of dollars.

Let me dwell on this a little longer for another reason—really important to these people—and that is to fix the time of the first visitation of the worm. When I found a small spot in this field, and, as it happened, at a distance from the path which traversed it, where, from its blackened appearance, one would have thought the cotton dead or eaten with rust, with no leaves, and only a moderate supply of bolls at the bottom, it was not difficult to detect the work of Aletia, and to fix the date about the middle of July. The eggs, then, were laid probably as early as the 1st; and this was the work of one moth. She had been driven before the prevailing southwest winds for miles, and, weary, put out her whole brood, of possibly 500, on the first spot where she found undisturbed repose. This is the earliest date I have ever been able to fix with certainty. It shows that the cotton planter even this far north must begin his vigilance by the 4th of July. The crops are laid by about this date, and a season of rest and negligence occurs on the Southern farm. To guard against this danger, a part of this grateful rest must be given to inspection. The first mother moth is apt to lay her eggs all near together, or, if disturbed, does not fly far. The worms being thick, and occupying small territory, are easily destroyed.

When I reached the field of battle they were scattered for miles and only a few in a place. To see the effect of the kerosene I was compelled to collect the worms from a considerable space around, to the stalks I proposed to sprinkle. This was September 5, having received information only a day before, whilst preparing to go farther south. In no one spot could I find them thick, or army-worm fashion, yet there were very few fields, or spots in the fields, in which worms or pupæ were not to be found, and the flies were literally everywhere. At night the flies came in numbers wherever there was a light. When pointed out to the people the general information was that that particular fly had been around the lamps for a month. This agreed well with the information of Mr. J. Walker, on whose place they first appeared. It was about the middle of August they (he and his tenants) first observed the ragged leaves in numerous localities, and the last of August before worms were noticed by farmers a mile or so farther off. The worms then observed by farmers, the 10th to 15th of August, were a second brood. and those I found at work September 5th must have been a third generation. To have combatted the evil at this date would have required considerable outlay and horse apparatus for poisoning the fields. I could get none of the planters to try it, because of the general impression at this date (5th to 15th of September) that the worms were not injurious. In fact, many rejoiced to see them. They regarded them as checks to the luxuriant growth of weeds and leaves, and thought they would promote opening of the cotton, generally so backward. An early frost would have caught the most of the cotton unopened. As it actually turned out, the fall was very late and protracted into even the usual winter, and if the worms had been kept back, the *top crop*, which not often matures here fully, would have been enormous.

Experiment No. 1 was made with a very weak kerosene emulsion: 60 parts of water to 1. The emulsion itself had been prepared with 1 quart of oil to 1 pint of milk. More milk was added to perfect the butter—about half pint, warm. This application killed all the worms sufficiently wetted with it; cotton leaves and stalk thoroughly drenched without any apparent injury; surviving worms next day found feeding on leaves as if nothing had happened.

Experiment second: Same with 30 parts of water. The least drop of this on a worm sickened him. So many were killed that the few escaping I concluded had not been touched. Practically, but few of the leaves could be wet on the under side. I used a fine fountain pump, of patent 1878. But many of the leaves were found spotted from the kerosene. My emulsion, I fear, was not perfect, and probably had some free oil.

In progress of this experiment I observed something that may be of interest. Pupæ were numerous, and most of them were inclosed in a half roll of the leaf, as usual. The liquid, applied generally to the leaves, was seen to run down into these nests, and many of the pupæ were set to wriggling. I then gathered a great many of them, and tried the emulsion on them, of various degrees of strength, and applied in different ways: First, of this strength (30 to 1), thoroughly wet by hand or dipping them in the liquid; all died; stronger solutions the same; weaker not tried. Secondly, a dozen, gathered with the stalks, so as to leave them hanging, as in the patch, in a cluster, were sprinkled, as in the field, and then caged. Within a week two flies came out. The cases whence they issued were found not saturated with the oil. All the others exhibited traces of oil, and, though perfectly dead, showed no other signs of disease or parasites, and very little progress towards putrescence.

I thought these two last experiments worth reporting, as they may have a bearing upon the destruction of chrysalids of other genera.

But my conclusion I think it also proper to state. Although much of it may be considered deduction from imperfect experiment, I do not perceive any hope of kerosene competing with the arsenious poisons for cotton worm: 1st, it can never be so cheap; 2d, it must *touch* the insect to be effectual. Paris green sticks to his food, and whenever he eats leaf enough he must die. I think, however, for cabbage worms and any collections of caterpillars the kerosene is the thing. I intended to try it on some social caterpillars I found congregated on hickory trees, but in one night after finding them they had completed their moult and dispersed. Circumstances then intervened which prevented my identifying my interesting hickory worm.

I have many chrysalids of Aletia yet, which I keep dry, but otherwise exposed to the climate, to see how they will winter.

There is only one other set of observations to report upon; and, looking at its barrenness of results, this deserves no notice. For several days and nights I had good opportunity to watch the moths of the cotton field. The owner of a perambulatory sorghum mill and evaporator was at work in one corner of a cotton field from 5th to 15th of September. I took up my camp with him. The nights and mornings were unusually cool. In the very early morning hours I could find nothing, see nothing. The habits of *Aletia*, which I was after, remain still a mystery as to my skill. But I can say that up to 10 or 11 o'clock (p. m.) they were astir in clouds. Attracted by the fires at the sorghum works, they perished in countless numbers. But nearly all of those examined at the mill were males. The operator told me that where he had last made up a crop of the cane, somewhat farther south and west, the flies had been so numerous as to compel him to cover up his evaporator and suspend work until morning. The nights at that time were warmer.

[A severe malarial attack at this time (18th September) put a stop to this kind of investigation.]

After the 1st of October, being engaged in geological work, it was my fortune to travel eastward and southward: you may believe I did not forget the Aletia. It may be of interest to record the fact forced upon me that, after six or eight miles to the east of the Mississippi Central Railroad, I found no more cotton worm north of the Tallahatchie River. I do not say none were there, because people take so little trouble to publish facts of the kind, but it does seem highly improbable, or I would have seen or heard of them. All that was peculiar, that might have acted as a barrier, was the unbroken line of forest, never less than one or two miles in width, constituting the growth of the river bottom. As soon as I passed south of this barrier, at New Albany (some 40 miles east), I got into the paradise of cotton worms. They were everywhere, and increased in their pernicious effects as I advanced south. Yet not before I reached the middle belt of counties did I find farmers estimating the damage as anything considerable.

I cannot close this rambling, garrulous communication without a word about my old friends the Heliothids. They were exceedingly numerous in gardens and corn during the summer, but comparatively light on cotton. Probably this happened from there being a great deal of late corn, and because cotton was also late. Yet I satisfied many farmers that the damage done to what they call the *middle crop* early in August was beyond calculation. Not for this, though, have I referred to them, but to question the utility of lights to attract and destroy them, so commonly recommended in agricultural papers. At my sorghum camp I never saw a single Heliothis: not because there were none in the fields and woods. The worms of all ages could be found in the corn, whether hard, or late and young, and many in the cotton; not so numerous as they had been in July and August, but during the whole of September the flies could be found in the cotton fields. I have watched them by the hour slowly flitting from plant to plant, from about 4 p. m. till dark, capriciously tasting the secretions of nectar, or dropping an egg in a bud or square; but after dark I never was able to find one, on the wing or at rest. I had often noticed before that, though my window opened low, and into the garden infested with these moths, it was not common for one of them to come to the light.

And, apropos to the question of their food plants, I think I can add to the list the tree *Cercis canadensis* for the early spring, and among late summer and fall plants the varieties of *Penstemon*, so abundant in our woods. I did not *verify* my worm by rearing it to the imago in either case: but surely I cannot be mistaken in the larva and his manner of work. Besides, during the latter part of the summer and fall I have frequently found the moth, in the woods, flying most commonly about different species of the low herbaceous Scrophularaciæ. Once I found the worm (if not greatly deceived) nipping out the top bud of a Penstemon. And I am now disposed to think that *budded* grasses—that is, with the top, when about to shoot up to bloom, eaten out—was Heliothis' work, instead of Laphygma, to which I had formerly ascribed it. The latter, I must remark now as a later reflection, I never have found solitary in habits. They go in families more or less numerous.

Little as I have accomplished, I trust you will not find it altogether worthless; and that another season, whether in your service or not, I shall learn something more for the cause of science.

Believe me, ever, most respectfully, &c.,

LAWRENCE C. JOHNSON.

Prof. C. V. Riley,
Entomologist.

P. S.—Referring again to my summer notes, I find some views of Mr. J. M. Brooks, an intelligent planter of Waterford, in this county, on the treatment of Heliothis. He says, "*Worm* your early corn as you would tobacco. It is not half so tedious, and a great deal more effectual." He thinks that for two years he has greatly diminished their depredations by this means. One more adjunct he practices and recommends, and that is to keep hogs in plenty, and as soon as cotton is picked out put them in the fields. It is curious, he says, how they will take to the rows, and almost plow up the old stalks in search of grubs and chrysalids. This latter I have witnessed myself. They certainly must get a good many cut-worm pupæ; I fear Heliothids generally go too deep for them.

Again, truly, &c.,

L. C. J.

INDEX.

A.

Acrobasis nebulo in Florida, 35
Ægeria exitiosa, peach tree injured by, 36
Argiope fasciata, on cotton, 40
Agrotis annexa, on cotton, 44
Agrotis larvæ, injuring cotton, 44
    sorghum, 37
    tomato, 37
Aletia eggs eaten by ants, 48
    experiments on, 49
  habits of, reference to, 55
  larvæ, destroyed by Asilus flies, 40
    destroyed by Polistes, 40
    destroyed by Tree-frog, 40
    destroyed by Vespa, 40
    effects of emulsions upon, 42
    injured by mites, 45
    two species of Sphex preying upon, 40
    pupæ and eggs destroyed by frost, 38
  pupæ of, how affected by kerosene emulsions, 56
  xylina, 47, 48
Anisoscelis albicinctus, puncturing orange, 36, 40, 45
Ant, eating holes in orange leaves, 11
  feeding on exuding gum, 10
  injuring roots of the banana, &c., 35
  species of, nesting in gallery made by larva of Elaphidion inerme, 9
  the small yellow, in houses, 38
Ants, attending Aphides, 47
  feeding on Aletia eggs, 48
  species of, on cotton, beneficial, 40
Aphides, on cotton, 47
Aphis, on cabbage, 37
    melons, 44
    orange, 11, 17
    peach, 36
Apple, leaf-folder injuring, 35
Artichoke, insects injuring, 36
    Metapodius on, 36
Asilid fly attacking a dragon-fly, 40
  flies, three species of, destroying larvæ of Aletia, 40
Attus audax on cotton, 40

B.

Batrachedra rileyi in cotton bolls, 44
Bean, a species of weevil injurious to, 36
  injured by Eudamus, 36
  insects injuring, 36, 37
  Seirarctia larva on, 36
Benham's mixture, supposed composition of, 12
    effects of, upon scale, 12
Blue-stone, effects of, on orange, 10
Boll Worm, 50, 57
Boneset, decoction of, 51
Borer, Coleopterous, in orange, 9
Bran-scale, 10
    effect of Neal's mixture on, 11
    mode of spreading, 11
    where found, 11
Brooks, Mr. J. M., some views of, on Boll worm, 58
Broom-corn injured by a weevil, 37
    injured by Heliothis, 37
    insects injuring, 37
Buprestis larva, injuring pines, 56

C.

Cabbage injured by Mamestra picta, 37
    Plusia brassicæ, 37
  insects injuring, 37
Candytufts, Diabrotica injurious to, 53
Carpophilus ferrugineus attacking injured fruit 13
Cecidomyidous maggots feeding upon the Rust mite, 11, 13
Cerambycid, unknown, on grape vine, 35
Cercis canadesis and Penstemon, food plants of Heliothis, 57
Ceroplastes floridensis, 19
    how destroyed, 25
    how removed, 22
Chapin, Mr. S. F., reference to report by, in *Pacific Rural Press*, 5
China berries, decoction of, 51
Chufa, roots injured by termites, 37
Chrysopa larva, feeding upon Lecanium, 12
Citron, infested with rust-mite, 11
Coleopterous borer in orange, 9
Corn injured by a weevil, 37
    by Heliothis, 37
  insects injuring, 37
Cotton bolls injured by Heliothis, 44
  fields, the Palma Christi in, 41
  injured by crickets, 44
  Louse (Aphis), 47
  planter, when to begin his vigilance, 55
  spiders on, 40
  stainer, 39, 44
  Worms, destroyed by parasites, 50
    invasions of, 44
    none until August, 54
    observations and experiments upon, 38–45
    paradise of, 57

Cotton Worms, real influence of ants upon, 47
  report upon, by Lawrence Johnson, 53
  Zamia solution on, 40
Cow-pea, insects injuring, 37.
Crematogaster lineolata eating pear leaves, 35
Crickets injuring cotton, 44
Cruciferæ insects injuring, 37
Cucumber, insects injuring, 37, 53

D.

Diabrotica, Pyrethrum most effectual against, 53
  the striped, on cucumbers and melons, 53
Dactylopius, on Persimmon, 36
Dragon fly attacked by an Asilid, 40
Dysdercus suturellus, 14, 39

E.

Eggs of Aletia eaten by ants, 49
Elaphidion inerme, larva of, boring in orange, 9
Emulsions, effects of upon the cotton plant, 42
  effects of upon the larvæ of Aletia, 42
  kinds and cost, 32
  of certain native plants, experiments with, 31
Epeira fera on cotton, 40
Epicauta strigosa on cotton flower, 45
Eriobotrya japonica, Leaf-folder on, 35
Eudamus, injuring the bean, 36
  peanut, 37
Euonymus, decoction of bark of, 51
Eupatorium perfoliatum, decoction of, 51
Euphoria melancholica injuring orange trees, 10

F.

Fungus on Parlatoria and Mytilaspis, 25
  smut, where found, 13

G.

Gasteracantha, species on cotton, 40
Geometer larvæ on Oak, 36

H.

Harlequin bugs, effects of kerosene emulsions upon, 53
  pyrethrum upon, 53
  mode of warring against, 54
Heliothids, notes in reference to, 57
Heliothis armigera, 50
  food plants of, 57
  injuring corn, 37
    broom-corn, 37
    sorghum, 37
    cotton bolls, 44
Hemerobius, larva of, eating Lecanium, 13
Hibiscus esculentus, emulsion of, 31
Hogs, as destroyers of certain insects, 58
Hominy scale, 26
Hubbard, H. G., miscellaneous notes on orange insects by, 9
  report by, on the use of kerosene emulsions, 6
Hubbard's formula, 33

I.

Invasion of Cotton Worm, 44

J.

Jatropha manihot, decoction of, 31
Johnson, Judge Lawrence, Report of, 53–7
Jute has no effect on Cotton Worm, 41

K.

Kerosene and whale-oil soap emulsions, estimate of cost, 18
Kerosene, how best combined, 32
  emulsion, application to cabbage, 53
  emulsions compared with arsenious poisons for Cotton Worm, 55
    effect of, in cold, damp weather, 17
    effect of, upon cucumber and melon vines, 53
    experiments with, upon Cotton Worm, 55
    experiments with, on purple scale, 17
    notice of the use of, in destroying insects, 5
    on cotton, 41
    on roots of orange, 6
    preparation of, 53
    reference to, 5, 13, 17
    results of experiments with, in California, 5, 6
    uses of, in destroying Scale-insects, 6

L.

Laphria thoracica vs. Cotton Worm, 40
Larvæ destroyed by ants, 38
Leaf-folder injuring apple, 35
  the pear, 35
  the quince, 35
Leaf-mining larva on mulberry, 36
Lecanium destroyed by Chrysopa larva, 13
    larva of Hemerobius, 13
  hesperidum, 13, 19, 31
  persicæ, 36
  scales of, how loosened, 22
    on orange, 11
Lemon, infested with rust mite, 11
  insects damaging, 36
Lepidopterous larva, rind of oranges perforated by, 12
Leptoglossus phyllopus puncturing orange stems, 36
Lime, insects injuring, 36
Lizzards in cotton-fields, 40
Locusts feeding upon orange leaves, 13
Loggerhead shrike as a Cotton Worm destroyer, 40
London purple for destroying Cotton Worms, 51
Long scale, effects of Neal's mixture upon, 11
Laphygma, reference to work of, 58
Lophyrus on pine, 36
Lye, applications of, 5
  concentrated solutions of, 7
  effects of, on orange, 10
  potash, experiments with, 7

Lye, various applications of, for destroying Scale-insects, 5
Lytta, a species of, injuring the potato, 37.
on beans, 36

M.

Macrosila cingulata vs. sweet potato, 37
quinquangulata vs. tomato, 37
Mamestra picta injuring cabbage, 37
Maranta aurundinacea, 31
Metapodius femoratus, 36
on artichoke, 36
Milk and soaps in emulsions, 33
condensed in emulsions, 32, 33
used with kerosene in making emulsions, 6, 13, 32, 42
Misumena vatia on cotton, 40
Mite, larva of Aletia infested with, 45
Mock-orange, decoction of, 51
Mulberry, insects injuring, 36
leaf-mining larva on, 36
leaf-rolling larva on, 36
Murvite, conditions necessary for its greatest efficacy, 22
cost of, at Gainesville, 38
experiments with solutions of, 19, 35
modes of applying, 19, 20, 21
solution, effect of upon the Rust mite, 25
experiments with, notes on, 25, 33
not injurious to parasites, 23
results obtained by the use of, 25, 26
Myrmica molesta and cotton aphis, 47, 48
Mytilaspis citricola, 10, 11, 12, 17, 18, 19, 31
gloverii, 10, 11, 12, 19, 26, 27, 29, 30
how removed, 22
smut on, 25

N.

Native plants experimented with for Cotton Worm remedy, 31
Neal, Dr. J. C., experiments on insects affecting the Orange, 35
general observations on destructive insects, 35
Neal's mixture, results of experiments with, 10
Nezara, destroyed by Diogmites, 40
Nitidulid beetle, attacking injured oranges, 12
Notolomus basalis, eating orange leaves, 13

O.

Oak, geometer larvæ on, 36
Oiketicus, girdling orange twigs 36
Orange, coleopterous borer in, 9
colored Reduvius, 13
Dog, the 37
effects of blue-stone on 10
fruit of, perforated by Lepidopterous larvæ, 12
injured fruit of, attacked by a Nitidulid, 12
insects affecting the, 36
leaves eaten by locusts, 13
Lecanium scales on, 11
Orange, the Red Bug an enemy of, 14, 38
trees injured by the web-worm, 36
twigs girdled by Oiketicus 36
Oxyope viridans on cotton, 40

P

Palma Christi, the, in cotton-fields, 41
Papilio cresphontes larvæ on orange, 36
plum, 36
Parasites of Cotton Worm, abundance of, 40
uninjured by murvite solutions, 25
Parasitized Cotton Worms, how distinguished, 41
Paris green, proportions of, for destroying Cotton Worms, 50
Parlatoria, fungus on, 25
Parlatoria pergandii, experiments on, 20, 25, 26
how removed, 22
Peach trees injured by Ægeria exitiosa 9
Peanut injured by Eudamus, 37
Pear, leaf-folder injuring, 35
Persimmon, Dactylopius on, 36
Pieris, the European, early appearance of, 36
Pimpla conquisitor vs. Cotton Worms, 41, 50
Pines injured by Buprestis larva 36
Pine, Lophyrus on, 36
Plum injured by Papilio cresphontes, 36
Plusia brassicæ, cabbage injured by, 37
Podisus destroyed by Diogmites, 40
Polistes, three species of, preying upon Aletia larvæ, 40
Pomolo-citron roots, insects infesting, 36
Potato injured by a species of Lytta, 37
Prodenia larva on sweet potato, 13
Proctocanthus milberti, 40
Prunus caroliniana, decoction of, 51
Pteris aquilina, emulsion of, 31, 42
Pyrethrum, experiments with, on Cotton Worms, 51
experiments with the diluted extract of, 9
water preparation of, 51

Q.

Quince, leaf-folder injuring, 35

R.

Raphigaster hilaris vs. Boll Worm, 50.
Red Bug as an enemy of the Orange, 14, 38
Reduvius on trees infested with Lecanium hesperidum, 13
the orange-colored, 13
Rust mite, experiments on, 9, 12, 17.
destroyed by Cecidomyidous larva 11, 13
infesting the citron, 11
infesting the lemon, 11
signs of presence of, 9

S

Scale-insects, effects of Benham's mixture upon, 12
experiments upon those affecting the orange, 19
how loosened, 22
loosened by storm, 23

Seirarctia larva on beans, 36
Sesamum indicum, emulsion with, 31
Smoke, as a remedy for Cotton Worm, 41
Smut fungus, where found, 13
Soap and milk emulsions, 33
    whale-oil, as remedy for scale insects, 5
Solanum aculeatissimum, decoction of, 51
    nigrum, decoction of, 51
    pseudocapsicum, decoction of, 51
    berries, alcoholic solutions of, 51
Soldier-bug vs. Boll Worm, 50
Sorghum injured by Heliothis, 37
Sphex, two species preying on Aletia larvæ, 40
Sphinx coniferum injuring pine, 36
Spiders eating Cotton Worms, 48
    on cotton, 40
Strachia histrionica on cucumbers and melons, 53
Sulphates of iron and copper, effects of, on orange, 10
    zinc, for destroying Cotton Worms, 51
Sylvanus quadricollis in cotton bolls, 36, 44
Sweet potato, injured by the larva of Prodenia(?), 13

T.

Tachina aletiæ, abundance of, 41, 50
Termes flavipes injuring orange trees, 36
Termites injuring roots of the chufa, 37
    various roots injured by, 36
Tree frog, destroying Aletia larvæ, 40
Trifolium repens, decoction of, 51

V.

Vespa, two species preying upon Aletia larvæ, 40
Vitis vinifera and V. labrusca, insects injurious to, 35
Voyle, Joseph, Report by, 19–30

W.

Web-worm, injurious to young orange trees, 36
Weevil, a species injuring broom-corn, 37
    corn, 37
    bean, 36
Whale-oil soap, applications of, for destroying Scale-insects, 5
    effects of on orange, 10
White clover, decoction of, 51.

Z.

Zamia integrifolia, emulsions with, 31
    solution, composition of, 33
        cost of, 33
        on cotton, 42